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## CANCELLOUS BONE LESIONS \*

NON-TUBERCULOUS, NON-SYPHILITIC, NON-SUPPURATIVE, NON-MALIGNANT

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EXCLUDING from consideration the disease termed "infantile rickets," the intra-osseous lesions of the long bones coming under the observation of the surgeon that are distinctly non-syphilitic, non-tuberculous, non-malignant and non-suppurative have been generally regarded as of infrequent occurrence.

The writer reports a series of 20 cases of cancellous bone involvement, that, so far as it has been possible to ascertain, cannot be classified with any of the above-named processes.

Neither can the cases herein reported as systemic lesions, in the present state of our knowledge, be grouped with the diseases of bone whose etiology is known to be due to disturbed metabolism through the ductless glands.

During the past three years the writer has been able to collect a number of these very interesting bone lesions requiring surgical relief and attention, and owes many thanks to his chief and co-workers on the surgical staff of the New York Hospital for Ruptured and Crippled for their encouragement, material aid, and good-will, in referring to him many of the patients observed.

The cases presented are readily divisible into three separate groups of cancellous bone lesions as follows:

Group 1. Metaplastic osteomalacia—systemic lesions.

Group 2. Hemorrhagic osteomyelitis—local lesions.

Group 3. Osteochondrofibroma—congenital tumor.

To Group 1 belong the multiple lesions in the long bones that have been so well described by F. von Recklinghausen in his very complete work covering the subject published in 1910.

Under the subtitle "metaplastic osteomalacia" he decides that *ostitis deformans* (Paget) and *ostitis fibrosa* (von Recklinghausen) belong in this more general term for these systemic bone pathologic changes.

Histo- and chemico-pathological investigations have failed thus far to

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lift the veil of obscurity under which the true etiology of the systemic lesions (coming under Group 1) remain hidden.

Chemicopathologic research has shown that there takes place an abstraction of the inorganic salts from the involved bone structure—so-called halisteresis—and its replacement with osteoid tissue. According to Wells (*Chem. Path.*, 2nd Ed., p. 404) the effect of this is to lessen the weight of the bone 20 per cent. to 40 per cent.

McCrudden (*Arch. Int. Med.*, March, 1910) found, in the bones of human osteomalacia, that together with a decrease in calcium there is an increase in magnesium and sulphur because of newly-deposited tissue poor in calcium. It has been suggested that an acid or insufficient alkaline content in the blood is perhaps a factor in dissolving the salts.

Feeding patients with calcium and phosphates has no effect on the disturbed metabolic process. In cases of osteomalacia it has been frequently observed that excess of calcium is given off in the urine, and much larger quantities are found in the feces.

The rôle played by the secretions of the thyroid, thymus, hypophysis, ovaries, testicles, pancreas or spleen have thus far failed to illumine our knowledge as to whether or not any particular gland or group of them is responsible for the pathologic process found in bone described as osteomalacia. For a long time the ovary had the distinction of being considered the offending organ causing the adult type of the disease in the female, and cases are reported of cure following oöphorectomy.

Further research and investigation is needed from a chemiophysiology and chemicopathologic stand-point, of the function of the bone-marrow as a contributing factor.

It is stated (Wells, *Chem. Path.*, 2nd Ed., p. 404) that senile osteoporosis differs chiefly from osteomalacia in that in the former condition no new osteoid tissue is formed.

McCrudden (*Arch. Int. Med.*, March, 1912) in his paper on osteomalacia summarizes as follows: "The applications of chemical methods have led to the conclusion that bony tissue like other tissue is continuously being destroyed and replaced by new, and that osteomalacia is due to a disturbance of balance whereby the new tissue is poor in lime salts and therefore soft." The starting point in these lesions is caused by an increased catabolism of bony structure due to the need of calcium salts elsewhere. Increasing destructive metamorphosis leads to a bending of the bones.

In the systemic disease of bone termed metaplastic malacia by von Recklinghausen the spongy structure is converted into, or replaced by, fibrous tissue with or without naked eye cystic areas.



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It was this macroscopic and microscopic picture of fibrosis that caused him to describe the lesion as *ostitis fibrosa* in his *festschrift* published in 1891. Inasmuch as we have no definite proof that the lesion is an inflammatory process the more recent term seems to better describe the disease.

An intelligent understanding of the pathologic phenomena taking place in these lesions is necessary to the surgeon, inasmuch as he is called upon to give surgical aid in correcting deformities and pathological fractures that the diseased process gives rise to.

The routine use of the X-ray has been of great value to the surgeon in throwing much light upon and demonstrating the presence of many cancellous bone lesions that give only trivial clinical symptoms of their presence.

In our work covering this field of bone lesions we have procured skiagraphs of the entire skeleton in all cases in which there was a suspicion that more than a single focus existed.

### GROUP I. METAPLASTIC OSTEOMALACIA—SYSTEMIC LESIONS

CASE I.—In the first case of this series the blood pictures taken on several occasions have shown a practically normal red cell and differential leucocyte count, hæmoglobin and color index slightly below. In the last differential count an absence of eosinophiles was noted.

Several urinary examinations (24-hour specimens) were negative for Bence-Jones bodies.

Two recent Wassermann tests were negative. Pain has never been a symptom.

The patient has never been incapacitated apart from the period given over to treatment for osteotomy and recovery from pathologic fractures.

X-rays of the entire skeleton have been made, and no bone involvement found above the pelvis. Size of the skull is normal.

The further history is as follows: Maurice C., male, white, age twelve years, normal height and weight. Healthy looking. Family history negative. Measles when 3 years old. No other illnesses.

When 5 years old tripped and fell over a stone, while running, resulting in fracture of the left femur (lower third). Later union with marked knock-knee deformity.

At the age of seven years had another fall, again causing fracture at site of former injury, union resulting with about the same degree of deformity that previously obtained.

One year later (child eight years old) osteotomy was per-

formed for correction of left knock-knee. Plaster-of-Paris dressings applied for several weeks, after which a raised shoe was worn to overcome shortening of limb.

Gave up wearing high shoe one year ago, and now presents himself for treatment of recurrent left knock-knee deformity which greatly interferes with locomotion (Fig. 1).

Measurements are as follows: Ra., 28 inches; La., 25 $\frac{3}{4}$  inches. Tibiæ of equal length.

X-rays (Figs. 2, 3 and 4) show marked destructive disease of left pelvic bones and entire length of the left femur. The left tibia is apparently normal, left fibula shows involvement in the diseased process.

The right ilium and right femur do not give evidence of any active destructive process being present, neither do they give (in the opinion of the writer) the clear-cut picture of normal bone; the right ilium and upper end of right femur present a somewhat hypertrophied, boggy appearance.

All of the bones above the pelvis of this patient are negative in so far as the X-ray is diagnostic of disease.

June, 1914: Osteotomy for correction of left knock-knee deformity. Supporting brace to be applied later. Organs and chemiotherapeutic and special dietary regimen to be tested and observations carefully noted and reported later. This patient is now in charge of Dr. W. Frieder of this city to whom I am indebted for the records in the case.

CASE II.—Francis L., male, white, age six years. Family history negative. No tonsillar or other infectious diseases. No history of injury. Has been limping, tripping and falling for last two months. Has never complained of tenderness, soreness or pain in either limb. Does not have night cries. Examinations of hip-, knee- and foot-joints absolutely negative. Child has weak feet for which correction shoes are prescribed.

Returned three months later for further treatment—there is no improvement in gait.

An X-ray (Fig. 5) taken at this time shows enlargement and slight coxa vara of the left femur. Applications of spica plaster-of-Paris dressing applied. Wassermann taken and negative report made, in spite of which antileptic therapeutic treatment was persisted in for 6 months. Nine months later another X-ray (Fig. 6) was taken which shows further progressive destruction of the upper end of the left femur, beginning disease of the neck and trochanteric region of the right and double coxa vara. Another Wassermann taken proved to be negative; several graduated doses of tuberculin were given, with negative results.



FIG. 1.—Case I. Metaplastic osteomalacia, juvenile type. Photograph showing marked left knock-knee deformity, due to bone softening.

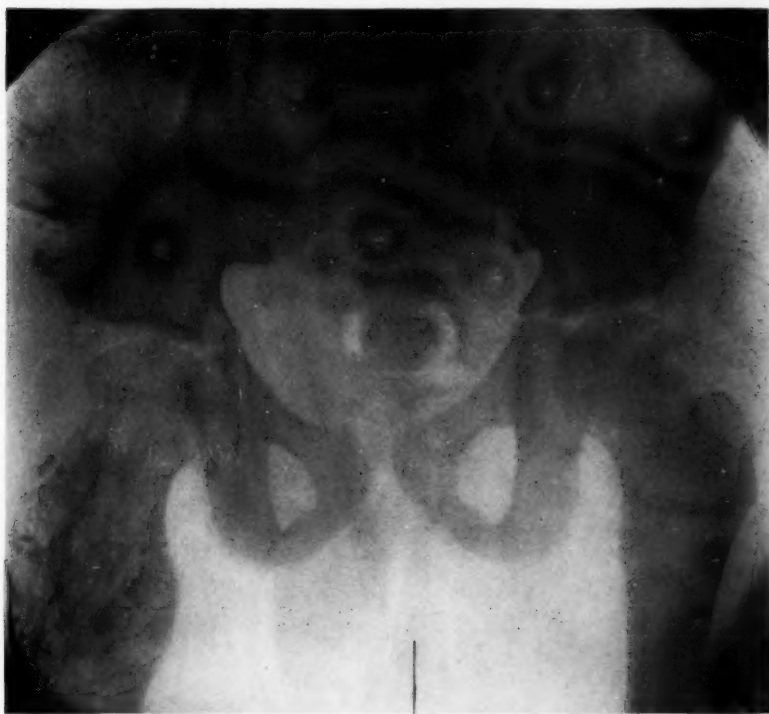


FIG. 2.—Case I. X-ray showing extensive pathologic change of left ilium and upper end of left femur.



FIG. 3.—Case I. X-ray shows the same process occupying the middle and lower thirds of left femur.

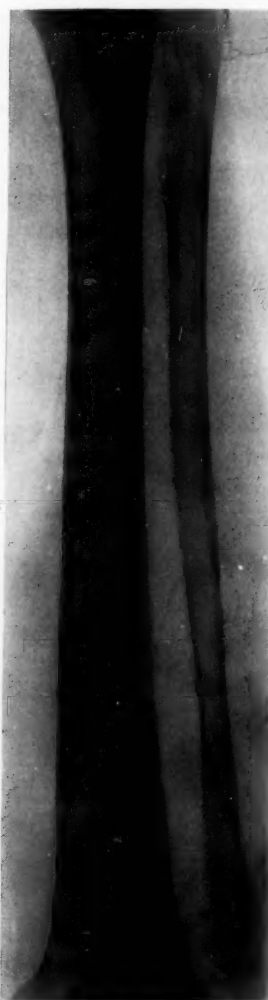


FIG. 4.—Case I. X-ray showing lesions in upper and lower ends of left fibula.





FIG. 5.—Case II. Metaplastic osteomalacia, juvenile type. Note hypertrophic X-ray appearance and irregular contour of neck and trochanteric region of left femur. Coxa vara present, due to softening. Right femur normal.



FIG. 6.—Case II. Same patient nine months later. X-ray shows progressive disease of the left and involvement of the right femur. Also note double coxa vara.

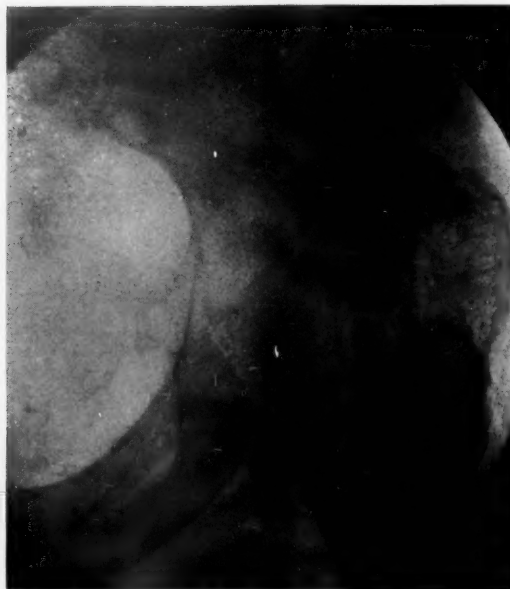


FIG. 7.—Case III. Metaplastic osteomalacia, adult type. X-ray showing displacement, distortion of contour, and disease of upper end of right femur.



FIG. 8.—Case III. X-rays of tibiae of same patient, showing slight bending and thickening.

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This case is still under the care and in charge of Dr. W. Frieder to whom I am under obligations for the record and X-ray plates. Clinical and X-ray diagnosis: Metaplastic osteomalacia, juvenile type.

CASE III.—Kate G., female, white, foreign birth, age forty-nine years. Multipara. No miscarriages. Last child born 15 years ago. For about 10 years has noticed that right leg seemed to be shorter than left. No history of injury. Has never had any discomfort or pain in right hip. Comes for treatment for relief of pain in her lumbar region which has been more or less constant for 5 years.

Examination shows flexion deformity of 40 degrees, adduction of 20 degrees and shortening of right limb.

X-ray (Fig. 7) exhibits pronounced hypertrophic distortion, obliteration of contour of normal lines, and displacement of upper end of the right femur.

Wassermann negative.

The X-ray (Fig. 8) shown here of the tibiæ of this patient if regarded independently might suggest a leucic process. Negative clinical signs, history, and Wassermann reaction rule this out. Skull normal; all other bones give a negative X-ray picture.

Clinical and X-ray diagnosis: Metaplastic osteomalacia, adult type.

### GROUP 2. HEMORRHAGIC OSTEOMYELITIS—LOCAL LESIONS

Group 2 comprises those solitary cancellous bone lesions to which the writer has given the term hemorrhagic osteomyelitis.

These localized inflammatory processes occur most commonly in or near the ends of the long bones. When through operative interference the lesions are exposed—and depending upon the stage of reaction present—one of two general clearly defined forms are exhibited, namely, the hemorrhagic granulation tissue (solid) lesion or the fibrocystic or wholly cystic lesion.

The etiology apparently is primarily due to trauma, causing localized destruction of bone trabeculæ, dilatation and varicosity of blood-vessels, hemorrhagic effusion, nutritional inhibition and, further, more or less symmetrical bone trabeculæ destruction from local pressure necrosis. Efforts at regeneration begin by the formation of young hemorrhagic granulation tissue. Inability of the host to restore architectural arrangement and function results in lesions that may properly be termed localized hemorrhagic osteomyelitis.

Lacking sufficient stimulus, with consequent absence of fibrin, the lesion retains throughout its course the primitive hemorrhagic granu-

lation tissue picture, the process of métaplasia being practically absent. In this form of osteomyelitis the diagnosis is quite generally incorrectly made of medullary giant-cell sarcoma, myeloma, medullary giant-cell tumor, etc.

The writer in papers recently published (*ANNALS OF SURGERY*, February, 1913, and *Surgery, Gynecology and Obstetrics*, July, 1914) has discussed the place the giant-cells occupy in this inflammatory process. A more active stimulant reaction with increased fibrin production causes local metaplasia and converts the hemorrhagic granulation tissue into fibrous structure with consequent retraction and cyst formation. This advanced form or stage of the initial lesions gives an operative picture of a localized fibrocystic osteomyelitis.

The writer is of the opinion that in some instances the stimulant reaction is active enough to prevent further tissue destruction, to absorb all débris, and to form a more or less dense bony wall around the cavity that nature's efforts have failed to obliterate. The solitary bone lesions usually classified as benign bone cyst, osteitis fibrosa, chronic osteomyelitis fibrosa cystica or solida, solitary bone cyst, etc., apparently have their origin in this way. Inasmuch as these solitary fibrocystic lesions start as a localized osteomyelitis in which cancellous tissue destruction, hemorrhage and hemorrhagic granulation tissue play the initial rôle, the writer believes that clinically the term hemorrhagic osteomyelitis is the more exact one to use. Whether or not the lesion has advanced from the hemorrhagic (solid) to the fibrocystic, or purely cystic, stage, can only be determined positively during operative interference and exposure, and then only may a conclusive diagnosis be reached.

The use of the X-ray must always be availed of for diagnostic purposes. At present it has its limitations in aiding us in this work.

We are unable to state from the skiagraphs whether or not the more or less symmetrical lesions the pictures usually show are hemorrhagic (solid), fibrocystic, or cystic, whether they possess, or are without, any lining membrane.

The distribution of these lesions that have come under the observation of the writer during the past three years are as follows: Femur, 8 cases; tibia, 3 cases; fibula, 2 cases; radius, 1 case; ulna, 1 case; ilium, 1 case; total, 16 cases. Four of the lesions of the femur were in the upper end in the region of the neck and trochanter.

In two of the cases we were able to secure skiagraphs showing the lesions previous to and following pathological fractures. Four cases were in the lower end of the femur. Three of these lesions involved one or both condyles. The other case showed the inflammatory process



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about 2 inches above the condyles. Three lesions in the tibia occupied positions in the lower end. We have two cases showing the process in the fibula, both in its upper end, one case in the lower end of the radius, one just below the olecranon, and one in the ilium.

Of the 16 cases personally observed 10 have submitted to operative interference.

Two cases apparently will not require operation, reparative change seemingly going on. Two others have refused operation but are being kept under observation. Two cases have been lost sight of.

In the 10 cases operated upon exposure proved 5 to be solid (hemorrhagic non-metaplastic type); 4 were fibrocystic in character (metaplastic type); and one case was frankly cystic.

In only one case previously reported (*Surg., Gynecology and Obstetrics*, July, 1914) has the writer felt it necessary to perform amputation for this lesion. The mutilating operation in this instance being preferred on account of the enfeebled general condition of the aged patient and his evident inability to withstand the shock of the more prolonged operation of resection and transplantation that would have been necessary to replace the diseased bone. In several cases the writer has been content to curette, swab the cavity with iodine, and close the wound. In others where the cavities were larger partial filling has been accomplished by shavings removed from the normal bone. The lesions have healed *per primam*. There have been no recurrences.

The ages of the patients have ranged from 3 to 63 years. They were all white; no cases in the colored races have thus far come under observation.

The size of the lesions have varied from that of a coffee bean to a large goose egg.

The relation of the size of the lesion to the duration of the disease is quite indefinite. X-ray studies and clinical observation indicate that as a rule the process is a slowly progressive one.

A definite history of initial trauma was obtained in two-thirds of the cases.

A majority of the lesions were subjected to Wassermann tuberculin or von Pirquet reactions. In every instance they gave negative results.

The period of time elapsing from history of injury to onset of symptoms has dated from receipt of injury to 18 months later.

No lining membrane was present in 9 of the 10 cases operated upon. In only one case did the lesion exhibit wholly fluid contents and in this case there was no lining membrane, the wall of the cavity was ridged and much more dense and compact than normal cancellous bone.

The gross and microscopic pathologic pictures of the (solid) hemorrhagic granulation tissue process are identical in the largest and smallest lesions.

The clinical diagnosis of these lesions in the upper end of the femur is frequently difficult to make because they simulate very closely the symptom complex of hip disease of the acetabular type. The X-ray, of course, makes a correct diagnosis easy.

Two of the cases under observation, each one presenting a lesion in the lower end of the femur, are absolutely without symptoms at the present writing. Comparison of the X-rays taken recently with those taken several months ago shows decrease in size of the lesions and apparent regeneration taking place (Figs. 15, 16, 17 and 18). The treatment in one case (Case No. XV) has consisted in the application of numerous plaster-of-Paris bandages to the affected limb beginning from the time the process was first discovered, six months ago. The second case (No. XVI), in which regenerative repair is apparently progressing, has received no treatment whatever apart from surgical attention given by incision and evacuation of a hæmatoma of the soft parts near the site of the bone lesion.

A careful study of the clinical, X-ray, operative gross and microscopic pathologic pictures of Case No. XVII leads to the assumption that the initial lesion must have been much larger than the X-ray picture now shows, anatomical restoration having been almost completely accomplished by nature's efforts alone.

Reports in detail of 9 of the 16 cases collected, belonging to this series, have been published in *ANNALS OF SURGERY*, February, 1913, and *Surgery, Gynecology and Obstetrics*, July, 1914. A brief sketch of the cases not previously reported is here appended.

CASE XI (October, 1913).—Beatrice W., female, white, age eight years. Whooping-cough and measles several years ago. No tonsillar infections. No other illnesses. Family history negative. History of fall and bruising left hip six months ago. Onset of present disease three months ago, with pain in left hip and limp since. Last two months has had night cries. Examination exhibits slight atrophy of thigh and calf muscles on left side. Measurements are: Ra., 21¼ inches; La., 21 inches; has limitation of rotary motion in flexion; A. G. E., 175°; A. G. F., 80°.

*Clinical Diagnosis.*—Left hip-joint disease of the acetabular type. X-ray (Fig. 9) taken two days later shows an oval-shaped lesion occupying neck and trochanteric region of left femur about the size of a small hen's egg, the lateral boundaries of the lesion extending to the periosteal walls. X-ray diagnosis: Hemorrhagic

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osteomyelitis. Plaster-of-Paris spica bandages applied and reapplied until June, 1914.

Numerous X-rays taken during the interval show very slow progressive increase in size of the lesion, with increased limitation of motion of the limb. Wassermann reaction negative.

June, 1914, operation consented to. Exposure exhibited a hemorrhagic fibrocystic loose oedematous mass easily removed and separated with curette. There was free bleeding from the cavity walls which had no lining membrane. The naked eye appearance of the lesion was that of the transitional stage of localized hemorrhagic osteomyelitis, in which the solid mass was undergoing fibrocystic changes.

The microscopic report made from material curetted away is appended.

Examination shows a variable histological appearance. The bone trabeculae exhibit a slight degree of disorganization, and the medullary tissue evidence of fibrosis. The principal feature appears to be the presence of new-formed tissue composed for the most part of medium-sized fibroblastic cells. Here and there a multilobulated nucleus is seen and a rare mitotic figure. A few giant-cells of the foreign body type are observed about the areas of disintegration, together with moderate hemorrhage, scattered foci of pigmented cells, and round-cells.

CASE XII.—Francis M., male, white, age six years, well-nourished, healthy looking. Family history negative. No tonsillar infections. Measles and whooping-cough at eighteen months. No other illnesses.

One year ago fell down a flight of stairs, dislocating left shoulder and bruising left hip. Began to limp four weeks ago. Has no pain, no night cries. Examination shows slight atrophy of thigh and calf muscles on affected side. Is tender to pressure over trochanter. Left measurement  $\frac{1}{8}$  inch less than right. Rotation in flexion and hyperextension slightly limited.

*Tentative Clinical Diagnosis.*—Left hip disease acetabular type. X-ray picture (Fig. 10) exhibits a lesion oval in shape the size of a bantam's egg, occupying most of the neck and portion of the trochanteric region and extending laterally to the periosteum. A practical replica of Case XI.

*Clinical and X-ray Diagnosis.*—Hemorrhagic osteomyelitis. Wassermann and von Pirquet negative.

Operation advised and consented to. While awaiting room for admission to the hospital patient was put up in spica plaster-of-Paris dressing.

Several weeks later he was carried to the hospital and statement made that some hours previously he had tripped and fallen, was unable to rise or move the left leg, and was suffering great

pain. Plaster was immediately removed and an X-ray (Fig. 11) taken which shows a pathologic fracture at the upper boundary of the lesion without deformity.

*Operation* (June 14).—Operator, V. P. Gibney. Exposure shows darkened periosteum; a slight blow of the chisel easily penetrated the cavity from which fluid straw-colored contents were evacuated.

The lining wall of the cavity was hard and dense and was felt to contain numerous slight ridges. There was no lining membrane.

CASE XIII.—Vivian J., female, white, age four years, well-nourished. Family history negative. Has had several attacks of tonsillitis. Scarlet fever eighteen months ago. Malaria with convulsions one year ago. Whooping-cough last winter.

Eighteen months ago fell out of bed. Mother thought child was seriously hurt. Doctor's examination negative. Began limping four weeks ago. Has no night cries. Two weeks ago parent first noticed that when patient would go upstairs she dragged the left leg. Examination gives negative joint symptoms; measurements of lower extremities are the same. Slight pressure over left trochanteric region causes discomfort; deep pressure makes child cry.

*Clinical Diagnosis*.—Hemorrhagic osteomyelitis. X-ray (Fig. 12) shows the lesion in the upper end of the femur practically a duplicate of the two cases above reported. Three days after this X-ray was taken the child was again brought to the hospital with the report that a few hours before she had tripped and fallen, was unable to move her leg, and was screaming constantly from pain.

Another X-ray (Fig. 13) was immediately taken which shows fracture through the lesion with more deformity than was exhibited in Case XII. This is no doubt due to the fact that no plaster spica had been applied previous to the accident.

We are fortunate in being able to exhibit the lesions in Cases XII and XIII just previous to and immediately following pathological fracture.

It is a singular coincidence that Cases XI, XII, and XIII are practically duplicate and that in each case the upper end of the left femur is involved.

CASE XIV (Dr. W. Frieder has been kind enough to refer to and give me the following data from his notes in this case).—Dora K., female, age twenty-two years, came under observation about six and a half years ago complaining of discomfort and pain in right thigh. Definite enlargement of trochanteric region was noted. An X-ray was taken which showed a lesion occupying the neck and trochanteric region of the right femur. Six years





FIG. 9.—Case XI. Hemorrhagic osteomyelitis (fibrocystic type). X-ray of oval-shaped lesion occupying trochanteric region and neck of left femur.



FIG. 10.—Case XII. Hemorrhagic osteomyelitis (cystic). X-ray showing lesion of neck and trochanter of left femur; right femur normal. Duration of symptoms four weeks.

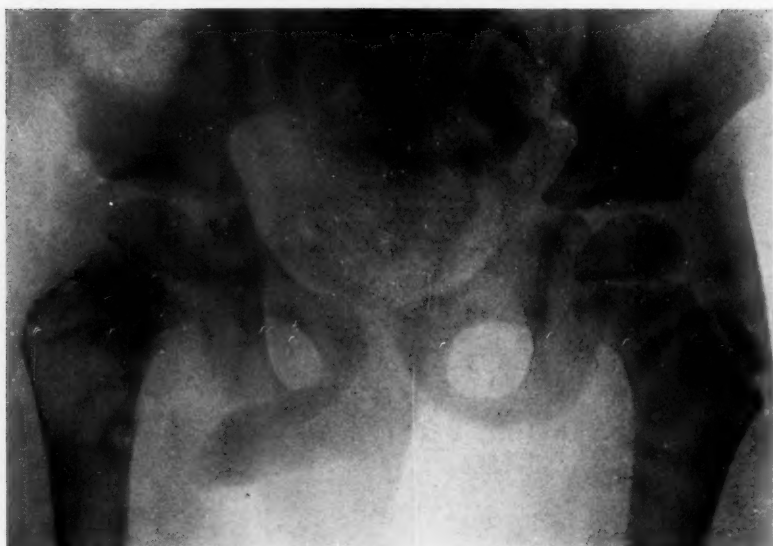


FIG. 11.—Case XII. X-ray taken five weeks later (same patient), showing fracture of the femur at upper end of the lesion; practically no deformity present, probably due to the fact that at the time of accident patient was wearing a spica plaster-of-Paris dressing.



FIG. 12.—Case XIII. Hemorrhagic osteomyelitis. X-ray shows oval-shaped lesion of upper end of femur size of a bantam's egg.

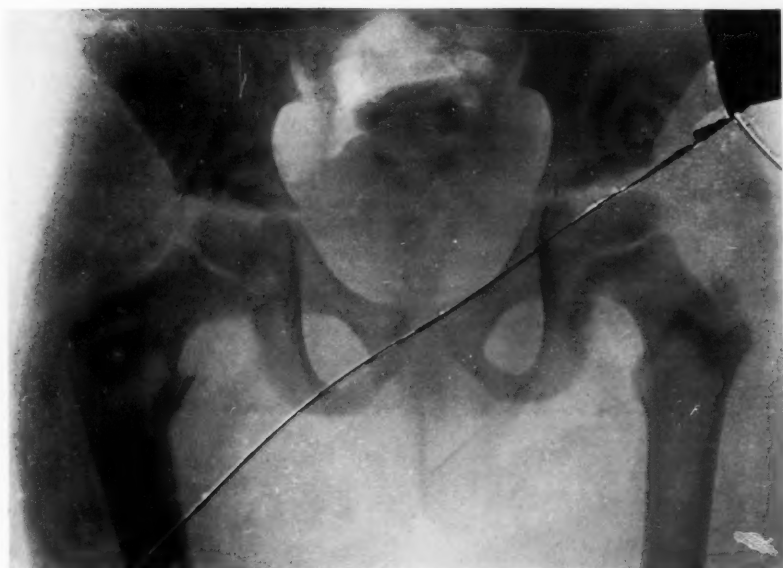


FIG. 13.—Case XIII. X-ray of same patient taken three days later, showing fracture at site of lesion due to fall.



FIG. 14.—Case XIV. Hemorrhagic osteomyelitis. X-ray showing the appearance of the upper end of the right femur six years after operation.



FIG. 15.—Case XV. Hemorrhagic osteomyelitis. X-ray showing lesion above condyle of left femur.



FIG. 16.—Case XV. X-ray taken six months later shows apparent regeneration and decrease in size of the lesion, even allowing for and taking into consideration the difference in density and size of skiagraphs.



FIG. 17.—Case XVI. Hemorrhagic osteomyelitis. X-ray, showing lesion in lower end of right femur, extending to the epiphysis; size of a lima bean.



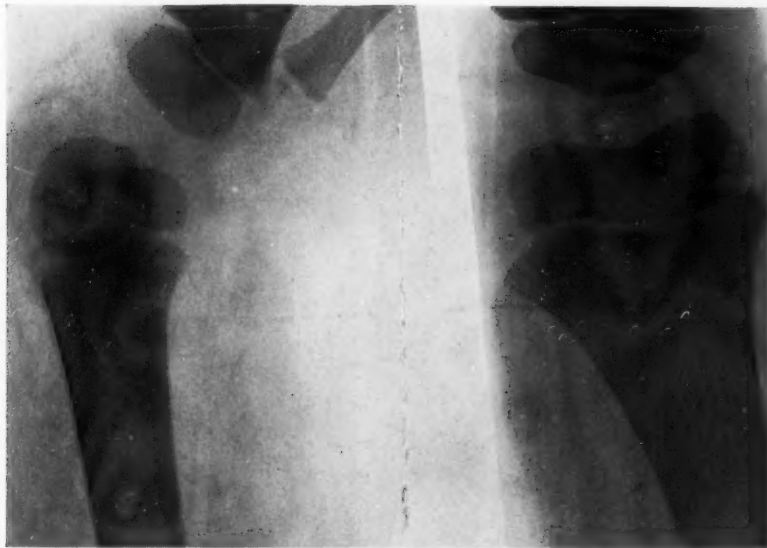


FIG. 18.—Case XVI. X-ray case three months later, showing apparent regeneration.



FIG. 19.—Case XVII. Hemorrhagic osteomyelitis, X-ray shows small lesion posterior border lower end of right tibia, and symmetric enlargement of lower fourth of the bone.

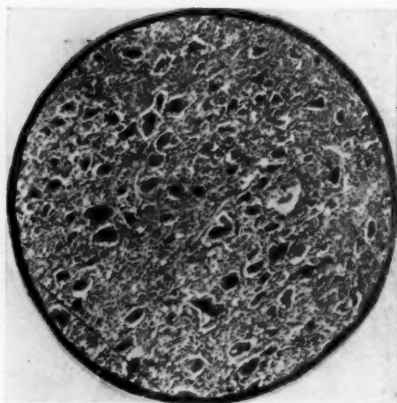


FIG. 20.—Photomicrograph. Hemorrhagic osteomyelitis. A typical field showing numerous giant-cells. Section taken from one of the lesions operated upon. Solid hemorrhagic granulation tissue type (X80).

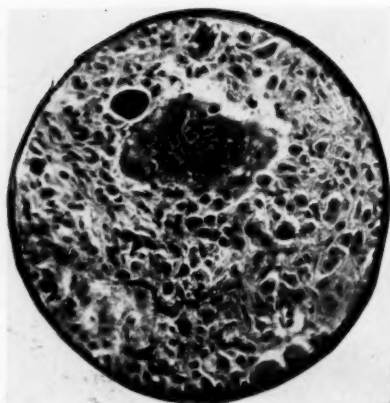


FIG. 21.—High power photomicrograph showing multinucleated giant-cell (X220). Hemorrhagic osteomyelitis.

NOTE.—The characteristics of this scavenger (giant) cell that differentiate it from the malignant true tumor giant-cell are the following: (1) The numerous nuclei present; (2) regularity of their arrangement; (3) uniform size of the nuclei; (4) the absence of mitotic figures; (5) vacuolation and abundance of the cytoplasm.

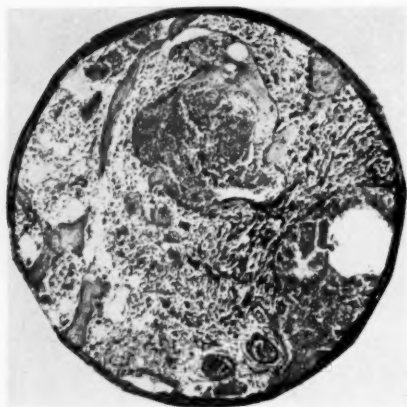


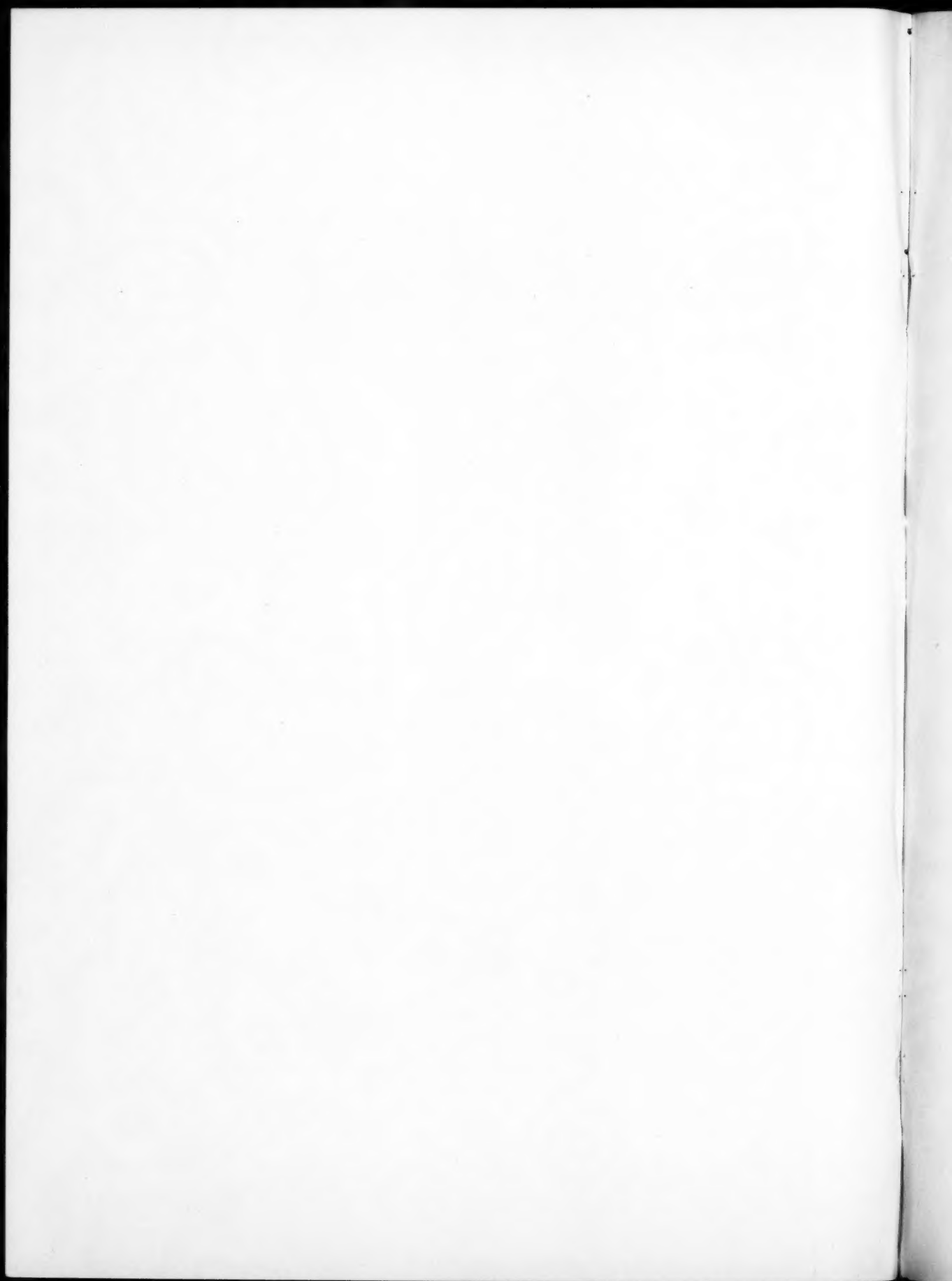
FIG. 22.—Hemorrhagic osteomyelitis. Photomicrograph from cut section, showing dilated and engorged blood-vessels, hemorrhage into perivascular tissue and erosion and disintegration of bone trabeculae.



FIG. 23.—Case I. Osteochondrofibroma. X-ray showing hypertrophy and obliteration of normal contour of upper end of left femur.



FIG. 24.—Case I. Osteochondrofibroma. Artist's drawing actual size of a cross-section of the gross lesion.



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ago an operation was performed by cutting into and curetting out the mass of sanguineous gelatinous material of which the lesion was composed.

A microscopic examination was made of the curettings and a diagnosis given of giant-cell sarcoma.

The X-ray (Fig. 14) recently taken shows the condition of the upper end of the femur six years after operation. She still complains of occasional discomfort in her hip. Several Wassermanns were negative.

CASE XV.—Alice P., female, white, age seven years, well-nourished, healthy looking. Family history negative. No tonsillitis, pneumonia, or other infective diseases. No history of injury.

About nine months ago child's mother noticed that the left knee seemed larger than the right and thinks it has slowly increased in size since. Has no pain and no night cries.

Examination shows enlargement of left knee. Circumferential measurement is  $\frac{3}{4}$  inch greater than right. Sensitive to slight pressure just above the condyles; deep pressure causes pain. X-ray (Fig. 15) taken February, 1914, exhibits an osseous lesion above the condyles. Wassermann and von Pirquet reactions negative.

*Diagnosis.*—Hemorrhagic osteomyelitis. Operation refused. Plaster-of-Paris bandage applied, and others renewed from time to time since. X-ray (Fig. 16) taken August, 1914, shows bone regeneration taking place and a decrease in size of the lesion. Deep pressure over the site of the lesion does not now cause pain. Circumferential measurement of the knee reduced  $\frac{1}{8}$  inch. Plaster bandage discontinued.

CASE XVI.—James C., male, white, age three years, healthy, well-nourished. Fell down four steps of stairway two months ago. Same night became very restless and cried from pain located above right knee-joint. No ecchymosis or swelling present. Apparently well three or four days later. About three weeks later mother observed that lower end of right thigh was much swollen and sensitive to touch. Home remedies having failed to reduce swelling, she now presents patient for treatment.

Examination shows lower end of the right thigh to be swollen; a fusiform area of fluctuation above the inner condyle is present. Measurements of left knee  $9\frac{5}{8}$  inches, right knee  $9\frac{7}{8}$  inches. An incision was made over the fluctuating area above the condyles and contents evacuated.

Clinical diagnosis: Hæmatoma. X-ray (Fig. 17) taken at this time shows a cancellous bone lesion present the size of a small lima bean, situated in the inner condyle of the right femur and extending to the epiphysis. Von Pirquet negative.



*Diagnosis.*—Hæmorrhagic osteomyelitis and hæmatoma of soft parts. X-ray (Fig. 18) taken three months later (August, 1914) shows regeneration and decrease in size of focus. Measurements of both knees are the same. The child exhibits no disability. No treatment or measure of immobilization has been applied. Anatomical restoration is apparently taking place without it.

CASE XVII.—Howard H., male, white, age six and one-half years. Family history negative. Has had measles; no other infectious diseases or illnesses. No history of injury. Fourteen months ago began complaining of crampy pains in right leg, at times very severe, which would frequently awaken him out of a sleep. These pains in the leg have been more or less constant for about one year. For several months has been unable to stand any pressure over the front of the leg in its lower third. The patient limps and at times is unable to walk. Has been treated for rheumatism for past nine months.

Examination exhibits a uniform non-inflammatory enlargement of the lower third of the right leg; it is quite sensitive to touch and causes pain on deep pressure. X-ray (Fig. 19) shows an irregular semi-oval spot on the posterior lower border of the right tibia. It also shows a uniform hypertrophy of the lower fourth of the bone. Wassermann negative.

*Operation* (June, 1914).—Exposure and cutting into the bone exhibits very vascular cancellous tissue. A small piece of much softer structure the size of a bean removed. The cavity curetted, swabbed with iodine and wound closed.

*Microscopic Report.*—Specimen consists of a few small, soft pieces of bone curettings. Microscopic examination shows congestion in cancellous tissue, otherwise nothing unusual found.

COMMENT.—The reporter ventures the opinion (based upon an analysis of the clinical, X-ray, gross and microscopic pictures presented by this case) that previous to operation nature had been successful in accomplishing almost complete regeneration of the diseased bone. The hypertrophied lower end of the right tibia, and history of long disability in conjunction with the microscopic findings of the removed tissue indicate that the initial lesion must have been much larger than the focus now presented by the X-ray (Fig. 19).

### GROUP 3. OSTEOCHONDROFIBROMA—CONGENITAL (BENIGN BONE TUMOR)

This cancellous bone lesion must be regarded as a true tumor—that is, an autonomous growth of benign characteristics possessing the potentialities for sarcomatous degeneration.

## CANCELLOUS BONE LESIONS

Several theories obtain as to the etiology of this growth. According to Virchow rickets is the prime factor. In the latter disease in the region of the epiphysis is found very extensive cartilaginous development, and processes of new cartilage project into what is destined to be the shaft of the bone; this may be cast off and isolated from the main mass. Under certain conditions these islands take on independent and aberrant growth, giving rise to enchondromata, osteo-enchondromata or true osteomata. Most modern authorities believe these growths arise from embryonal or developmental rests and are therefore congenital.

In this group only one case has been personally observed. It is here recorded on account of its rarity as a single growth in the cancellous bone and because of the interesting features it presents.

The following is the case history:

George C., male, white, age twelve years, well-nourished. Family history negative. Has limped since he was two years old. No history of injury. Has never had any tenderness or pain in affected limb.

Examination shows marked external lateral bowing of trochanteric region of left thigh. There is limitation of motion of hip-joint, atrophy of lower thigh and calf muscles, and considerable shortening of the limb.

Measurements: La., 27 inches; Ra., 28½ inches. In the erect position patient balances himself on the ball of the left foot, heel raised.

X-ray (Fig. 23) taken previous to operative interference shows marked hypertrophic disease of the upper end of the left femur. X-rays were also taken of the rest of the skeleton, all other bones giving a normal picture. Wassermann negative.

Operative exposure and removal of diseased bone show the growth to be a typical osteochondrofibroma.

As the cut gross section could not be brought out in detail on a photographic plate, the artist (Bosse) made an actual size drawing (Fig. 24).

The microscopic report (of sections of the growth) made by Dr. O. S. Hillman is as follows:

Microscopic examination shows the tumor to be made up of a framework of cellular fibroblastic tissue with rather delicate bone trabeculae embedded in it and circumscribed areas of cartilage.

The growth is covered by a fairly dense connective-tissue capsule; only a moderate number of blood-vessels are seen throughout the fibrous portion of the mass. No definite evidence of malignancy can be detected.

The growth is essentially an osteochondrofibroma.

## MULTIPLE CONGENITAL OSTEOCHONDROMATA

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G. H., a white male, aged thirty, unmarried, was admitted as a patient on the Surgical Service of the Washington University Hospital, St. Louis.

He presented himself for the treatment of a superficial abscess over a bony prominence on the left clavicle. On examination, a most remarkable condition involving practically the whole skeleton was disclosed.

A study of this case, including the X-ray findings, is the basis of this report.

*Family History.*—His parents are both living. The father, seventy-one years old, is well preserved and in very good health. The mother, aged fifty-four, is not strong and for many years has been in poor health. The nature of her trouble is not known. He has three sisters and five brothers all in good health and none of them, to the best of his knowledge, has any trouble similar to his own. Two brothers died in infancy and one sister died at nineteen, the cause of death being unknown. Two maternal aunts died of tuberculosis. He knows nothing of his grandparents and, so far as he has been able to learn, no condition similar to his has ever been present in any member of his family.

*Personal History.*—Patient has never been robust, but his general health has been fairly good. He had none of the serious diseases of childhood. At the age of twenty-three he had typhoid, from which he made a good recovery, without complications.

He has had two attacks of pleurisy in recent years and one attack of malaria. He has suffered frequently from headaches accompanied by gastro-intestinal upsets. Aside from the so-called attacks of pleurisy, there have been no symptoms referable to the cardiorespiratory system. His appetite has never been good; he has been a small eater and has always been troubled with constipation, otherwise his gastro-intestinal history is negative. He had a Neisser infection a few years ago but denies lues. There is no history suggesting a primary or secondary infection.

Neuromuscular system is negative. He has been a man of regular habits. Up to six years ago he did hard manual labor on a farm, but since that time has been a book-keeper.

*Present Illness.*—He has had multiple hard tumors all over his body as long as he can remember and at birth it was noticed that his arms were

## MULTIPLE CONGENITAL OSTEOCHONDROMATA

thick at the elbows and wrists. His mother stated that, up to the time he was about six years old, the lumps were not noticeable enough to attract attention, but at that time they began to grow, particularly those on the extremities. They grew proportionately to the general growth of the body and during the period of adolescence, from 16 to 22, their growth was most marked. Since the age of 22 he thinks they have stopped growing. In other respects his development has gone on normally and he has suffered no inconvenience from the presence of these tumors, except for the resulting deformity in his forearms. The limitation of motion produced here has made it necessary for him to give up hard manual labor.

Subjectively, he has been quite free from symptoms referable to the tumors. None of the long bones have ever been fractured. He had never sought medical advice and the only reason for coming at this time was for the treatment of an abscess caused by the rubbing of his clothing over a prominence on his left clavicle.

*Physical Examination.*—The patient is a fairly well-developed man, 5 feet 5½ inches in height. He shows no evidence of malnutrition or emaciation and is suffering no discomfort. There is a striking irregularity in the contour of the body and scattered over the trunk and limbs are numerous tumors arranged more or less symmetrically, which cause marked deformities in the bony framework, as shown in Figs. 1, 2 and 3.

The skull is apparently normal in shape and size and is the only part of the body which is free from the tumors. The jaws are prominent and somewhat thickened, especially the right one at the angle. The eyes are negative; no pathological changes in the fundi. The color fields show no restriction or abnormality. The nose is free from any bony deformity. The teeth are normally situated, are all present and in good condition. There are no deformities along the alveolar borders. The nasopharynx is negative.

There is no enlargement of the thyroid gland or of the lymph-glands in the neck or elsewhere. The heart and lungs are negative. The chest is asymmetrical, though fairly well developed, and moves normally on respiration. There are multiple tumors on the ribs averaging in size from a few millimetres to about two centimetres across. They are scattered everywhere, without reference to the costochondral articulations, and are all of bony hardness. They suggest exostoses and no diffuse enlargement of the ribs can be determined. The spine on examination feels normal except for a slight lateral deviation, no tumor masses being palpable.

The upper extremities: The right shoulder is much more prominent than the left, although on both sides there is a diffuse enlargement of the upper humerus, especially marked anteriorly. The muscles here, as elsewhere, are fairly well developed and there is practically no restriction of motion at the shoulder-joints. The right clavicle is more prominent than the left, but no nodules can be felt. At the left acromioclavicular joint is a very prominent bony mass, 6 x 8 cm. in diameter, over the apex of which the skin has broken down and is the site of an abscess.

The scapulæ are not markedly deformed and neither is winged, but



the left one is somewhat more prominent than the right and has numerous nodules scattered over the wing and spine measuring in size from 3 to 8 cm. There are fewer on the right side.

The right humerus is a little longer than the left; neither is markedly shortened. The right measures 32 cm., the left 28 cm. Except for the diffuse enlargement about the heads, both bones on palpation seem quite normal between the shoulder and elbow.

The most striking deformities are present in the forearms, particularly the left. Both are much shortened and the shafts, as well as the ends, are involved in the deformities. On the left side the bones are so distorted that the radius and ulna cannot be distinguished from one another. Extension and flexion are possible within almost normal limits, but pronation and supination are practically *nil*.

The right forearm is much less deformed, although the enlargement at the elbow-joint is much greater than on the left. Pronation in this arm is fairly good, but supination is impossible. The left forearm, from the external condyle to the styloid of the ulna, measures 14 cm., the right 21 cm. From the external condyle to the styloid of the radius, the left measures 16 cm., the right 21 cm.

There are multiple nodules to be felt about the right elbow-joint. Motion at the wrists is only slightly restricted and the hands, except for being somewhat chubby, show no very striking abnormalities. The last two fingers of the left hand are disproportionately shortened.

Numerous small nodules are palpable along the metacarpals and the phalanges.

The lower extremities: The pelvis is tilted, the right side being higher than the left. The ilium on either side is covered with nodules, both anteriorly over the crests and posteriorly. The left femur shows no marked changes at the upper end, but there are numerous nodules about the lower end, while the shaft seems clear and normal in length. There is no restriction of motion at the hip. The right femur presents a very large tumor posterior to the great trochanter and another just below this. On this side there is slight restriction of motion at the hip-joint, due to the mechanical interference of some of the larger tumors. The shaft again is normal, but at the lower end there is a more marked deformity than on the left, causing a definite genu valgum.

The bones of the lower legs all show thickening about the articular ends, with numerous palpable nodules. The shafts are clear and there is no shortening or marked deformity analogous to that present in the forearms. There are no palpable tumors on the feet, but there is some irregularity in the arrangement of the toes. The third toe on either foot is set back 1 cm. behind the others and is proportionately smaller. There is a moderate degree of flat-foot.

The left leg measures somewhat shorter than the right, but there is no noticeable limp in walking. Motion is nowhere restricted at any of the joints.

On inspection and palpation these tumors are all characterized by their bony hardness and their irregularity as to size and shape. Some



FIG. 1.



FIG. 2.

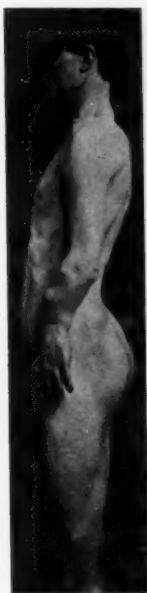


FIG. 3.



FIGS. 1, 2 and 3.—The head is normal in size and shape. Marked deformity of the upper extremities, particularly the left forearm and shoulders, with relative shortening of the arms; more marked on the left. Small tumors scattered over the ribs; larger ones in the region of the hips, especially the right. Legs normal in length. In general, the distribution of the tumors is fairly symmetrical.



FIG. 4.—The skull and upper cervical spine. The skull shows marked thinning in the vertex and the frontal eminences. Size and shape normal. Sella turcica normal. No bony outgrowths. The right lower jaw shows a marked exostosis at the angle, with thickening and irregularity of the ascending ramus. The freedom from involvement of the bones laid down in membrane is striking. The posterior spinous processes of the second and third cervical vertebrae show diffuse enlargement and bridging. The rest of the spine is normal, except for fusion of the fourth and fifth lumbar vertebrae.

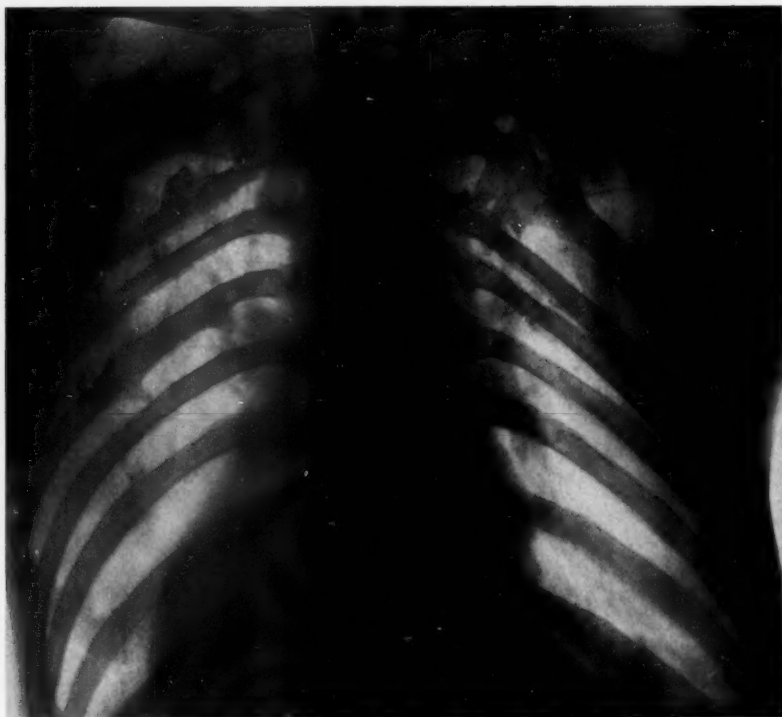


FIG. 5.—The thorax. On left side, multiple exostosis on third and fifth ribs. On the right side, the first, second and third ribs show marked deformity. Notice especially the third, which at one point is incorporated in an irregular bony mass, which displaces the ribs above and below it and causes them to overlap. Lower six ribs but slightly involved. Some clubbing at the costochondral articulations.



FIG. 6.—The left shoulder. The inner end of the clavicle is normal. At the outer end there is a large irregular mass which contains cystic cavities and involves the entire outer end and the acromion. The inner border of the scapula is irregular, and on the outer border at the junction of the middle and lower third is a large rectangular exostosis. The upper border is obscured. The upper third of the humerus is enlarged and club-shaped and shows a large single cavity with bony partitions. The cortex is irregular, thinned out, and in places seems to be broken through, particularly on the inner border. The lower two-thirds of the humerus are normal, except for one small exostosis on the internal condyle.



FIG. 7.—The right shoulder. The clavicle here is normal except for an exostosis at the outer end on the under surface, where there is cystic degeneration and the cortex is broken through. The scapula shows an exostosis on its posterior surface, lower third, while the whole inner border is thickened. The acromion is free. The humerus shows the same condition as that on the left, but the cortex here seems everywhere intact. The same bony partitions as on the left are seen in the enlarged cystic head. The rest of the humerus is normal, except for one exostosis on the internal condyle.

FIG. 8.



FIG. 9.



FIGS. 8 and 9.—The left forearm. The bones are greatly shortened and deformed. The ulna is the larger bone; its upper end shows little change. The shaft is short and stout, while the lower third is spread out into a large mushroom growth, displacing the radius inward. The enlargement shows trabeculae with minute cysts. The shaft of the radius is very thin and twisted around the lower ulna and its upper end is deformed by a bony overgrowth. Stereoscopic plates show these bones to be distinctly separated from one another. The lower end of the radius is somewhat deformed but its articular surface is little changed. The elbow-joint is negative.

FIG. 10.



FIG. 11.



FIGS. 10 and 11.—The lower right humerus and elbow-joint; the bones of the forearm and carpus. Except for the presence of a few small exostoses about the condyles, the lower humerus is normal. This condition also prevails on the left side. The upper ends of both radius and ulna show some deformity due to the presence of small multiple exostoses. The shafts of the two bones are of about the same size, the radius being more nearly normal. There is an exostosis on its ulnar side. The ulna is deficient in its lower third and spread out. Its radial side is rough and irregular. There is not the marked shortening of the bones which was present in the other arm. The carpal bones in this, as well as in the other wrist, show no marked abnormalities.



FIG. 12.—The left hand. The bones all show clubbing and shortening with the exception of the metacarpal of the index finger, which is normal. This abnormality is particularly well seen in the other metacarpals. The whole hand is stubby. There are a few scattered exostoses to be found about the ends of some of the bones and in places a beginning cystic degeneration.



FIG. 13.—The right hand. The bones of this hand are more uniformly thickened and clubbed than those of the left hand. The distal ends of all of them, almost without exception, bear small exostoses. There is also evidence of early degeneration in the ends of some of them. The thickening of the shafts is very well shown in the phalanges of the first, second and third fingers.



FIG. 14.—The pelvis and upper femora. The pelvic bones are enlarged and show multiple exostoses, irregular in size and distribution. One especially marked on the posterior surface of the left ilium. A large mass on the anterior surface of the sacrum projects into the pelvic cavity. One occupies the obturator foramen on the right side. The upper end of the femur on either side is greatly enlarged and club-shaped, with cystic cavities as in the humeral heads. The neck is practically obliterated and there is marked irregularity and proliferation along the inner borders from the lesser trochanter to the head. A large branching cauliflower exostosis with a stout bony pedicle arises from the outer posterior surface of the right femur. This mass shows cystic degeneration. A second large tumor arises from the shaft immediately behind this one. The middle third of either femur is normal.





FIG. 15.—The right knee. The lower femur and upper tibia are enlarged and both show marked thinning of the cortex. As seen elsewhere, there is the tendency to cavity formation and there are numerous exostoses on the posterior surface of the femur and the inner surface of the tibia. There is no deformity of the joint itself.



FIG. 16.—The upper ends of the left tibia and fibula. The head of the fibula is spread out and shows the characteristic cystic degeneration. This is not so evident in the tibia, but here there is also marked thinning of the cortex. On the fibular side of the tibia the cortex is absent in one place and there is fusion with the fibular head. There are numerous exostoses on the inner side of the tibia. The shafts of the bones are relatively normal in size and shape.



FIG. 17.—The right lower leg and tarsus. The lower ends of the tibia and fibula in both legs show almost the same picture. There is some enlargement of the bones with thinning of the cortex and cystic formation. The tarsal bones are larger than normal. The os calcis shows an exostosis on the upper posterior border at the insertion of the tendo Achilles and another on the plantar surface. The left tarsus is normal, except for slight enlargement of the os calcis.



FIG. 18.—The anterior portion of the right foot. First and second metatarsals normal except for slight clubbing. The third, fourth and fifth are all short and clubbed with fusion of the third and fourth at their distal ends. Phalanges of the second, third, fourth and fifth are all short and clubbed, with a median constriction of the first phalanx of the third toe. The metatarsals and phalanges of the left foot all show clubbing, with numerous small exostoses.

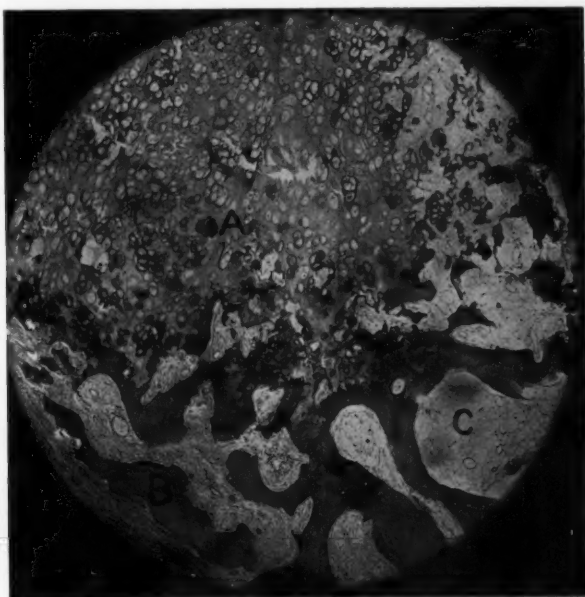
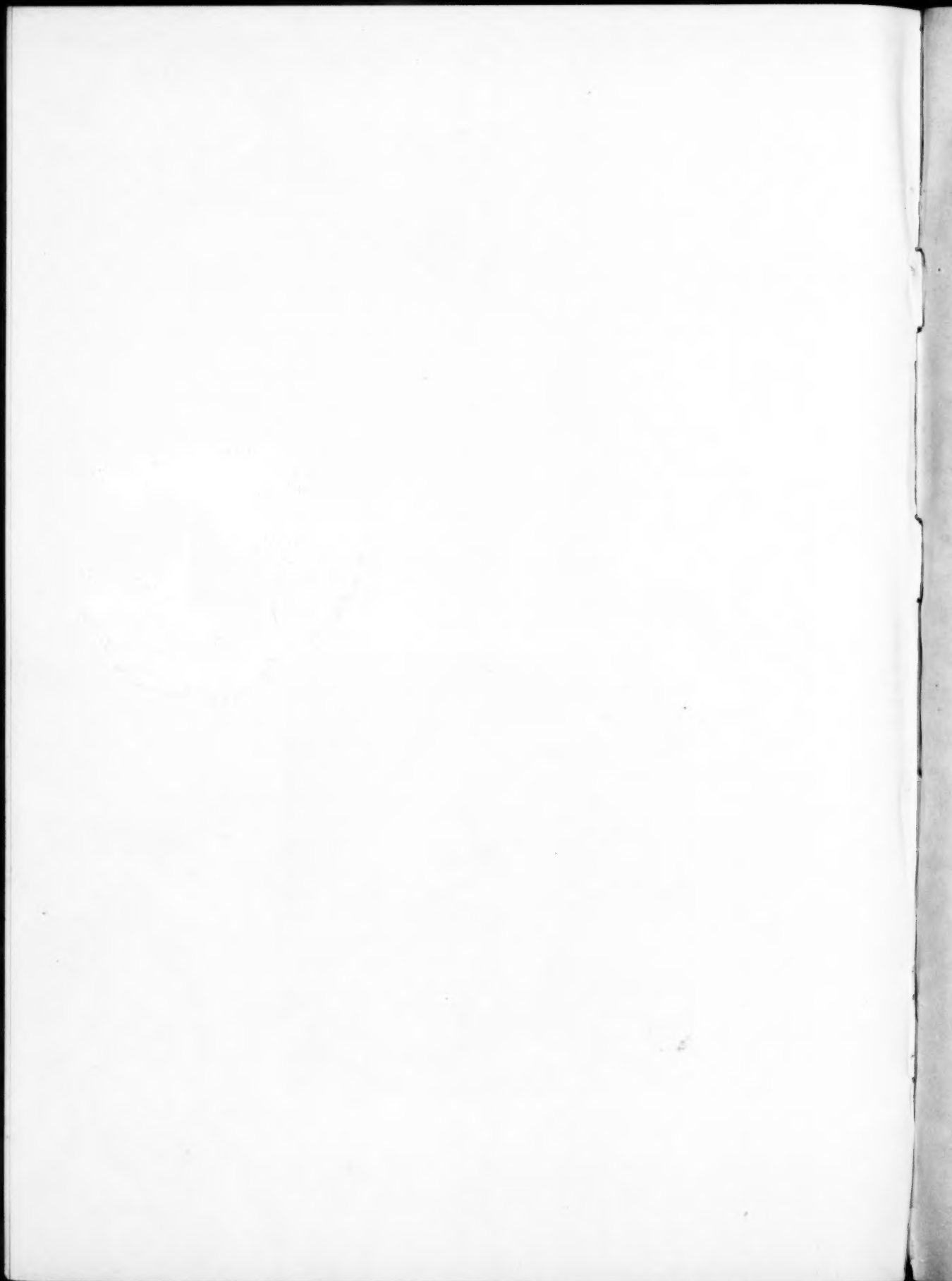


FIG. 19.—Section through the outer bony shell of one of the exostoses. *A*, hyaline cartilage with atypical cells; marked calcium deposits; *B*, fragments of dense bone; *C*, myxomatous connective tissue and fat.



## MULTIPLE CONGENITAL OSTEOCHONDROMATA

appear as typical exostoses, others as diffuse enlargements of the entire bone.

Rectal examination reveals a bony prominence projecting into the pelvis from the right ischium and pubis. There are no palpable masses arising from the coccyx or sacrum as far as the palpating finger can reach.

Abdominal examination is quite negative. Liver and spleen are of normal size. There are no palpable masses or areas of tenderness. The genitalia show no abnormalities.

The urine is free from sugar and albumin, and repeated tests for the Bence-Jones proteid are negative.

The blood picture is normal. There are 5,100,000 red cells and 9,000 leucocytes. A differential count of 400 cells shows lymphocytes 17.5 per cent., large mononuclears 7.0 per cent., polymorphonuclears 72.5 per cent., eosinophiles 2.5 per cent., and mast-cells 0.4 per cent. No pathological changes are seen in fresh or stained smears.

The Wassermann reaction is negative.

The sugar tolerance was lower than normal. For glucose it was found to be between 15 and 25 grammes, and for levulose, between 5 and 10 grammes.

The tolerance was in no way influenced by the feeding of pituitary extract (anterior lobe).

The abscess mentioned above was incised and drained and, when the infection had cleared up, a portion of the bony tumor under it was removed. At operation the tumor was found to be a cystic growth with a thin, hard, bony wall, arising from the outer end of the left clavicle.

Röntgenograms of the entire skeleton were made and their description accompanies the illustrations.

NOTE.—We desire to acknowledge our appreciation to Mr. C. A. Heckelman for the preparation of the röntgenograms and to Dr. W. S. Thomas for the microphotographs.

*Pathological Report.*—A portion of the tumor removed from the left clavicle shows the following picture.

On section the fresh gross specimen presents an outer shell of dense bone, which varies in thickness from 1 to 10 mm. and in places contains white, chalky deposits, which are brittle and can be scraped away. The inner portion is spongy, soft and trabeculated and contains an irregular cavity about 1 cm. in diameter, which is lined by a distinct membrane about 1 mm. in thickness, resembling fibrous tissue.

Sections through the thick chalky portion of the outer shell, Fig. 19, show the specimen to be made up of three distinct types of tissue: bone, cartilage and myxomatous tissue. The bone and cartilage are distributed irregularly, there being no very distinct line of demarcation, while scattered throughout the sections are deposits of calcium salts. The cartilage cells are rather indistinct, owing to the diffuse calcification. The myxomatous connective tissue is distributed in irregular areas, irrespective of bone or cartilage.

There are no evidences of inflammation or active bone destruction.

Other sections made through the wall of the cystic cavity show this

to be lined with a layer of rather dense fibrous tissue, through which are scattered deposits of calcium, with bits of bone and cartilage and other areas of fat and myxomatous tissue. Here again there is no evidence of inflammation. There is no striking vascularity of the connective tissue.

The case presents a number of features of special interest. Such a general involvement of practically the entire skeleton is relatively uncommon, the majority of the numerous cases reported in the literature being limited usually to lesions in the long bones of the extremities and the short pipe bones of the feet and hands. In this case the bones of the skull and face are the only ones not involved. This is the usual observation and is explained by the fact that these bones are laid down in membrane instead of cartilage.

The influence of heredity, which has been observed repeatedly and which is apparently unquestioned, does not enter as a factor in this case, although it cannot be entirely excluded, since the information on this point is meagre. So far as his immediate family is concerned, however, nothing similar to his condition is present. Perrin has recently reported three cases occurring in the same family and has collected 33 observations by other authors, in which heredity has been an important feature.

The progress of the tumors, which was extremely slow up to the age of puberty and most rapid from this period to the age of 23, is quite in accord with the usual history and the observation of Virchow and others, that the condition develops most rapidly during the growing period. With the cessation of the general growth of the body, the condition has remained practically unchanged.

The general involvement of the epiphyses, with the relative freedom from involvement of the shafts, is very striking and seems to support the most plausible theory advanced by Von Bergman and others with reference to the etiology of this condition, namely, that the lesions arise in abnormal anlage in the intermediary cartilages. Von Recklinghausen believes that there is usually an increased and faulty vascularization of these cartilaginous infolds and that this is an important factor. In our case certain abnormalities, particularly about the elbow-joints, were noticed at birth and Pels-Leusden contends that the anlage are always present at that time, but may be too small to be observed, or obscured by the soft parts. These cartilaginous infolds may be present at any point and it is readily conceivable that they may become detached from their normal position at the epiphyseal lines and be carried along with the growth of the bones, to develop later in the exostoses, which are frequently found along the shafts of the long bones. It seems less



## MULTIPLE CONGENITAL OSTEOCHONDROMATA

probable that these lesions may be due to an inflammatory process and in this case there is certainly no evidence to support this view.

Volkman lays considerable stress upon rickets as an etiological factor, but most other writers are not in accord with this view and Pels-Leusden correctly describes a different histological picture for the two conditions. In rickets the deformities are usually in the shafts and, while the epiphyses may be increased in size, they are usually normal in shape. Both conditions, however, may be present.

Other theories which have been advanced are, that it is a true heredity monstrosity or the manifestation of a derangement due to toxic infection, which is transmitted from generation to generation.

Aside from the suggestion of the trident hand, it bears no other relation to the condition of achondroplasia.

The absence of joint involvement is in accord with the general observation that the joints are rarely affected. There is some mechanical limitation of motion, however, at various joints, due to the neighboring tumors and deformities. In our patient there was marked shortening of some of the bones, especially those of the forearms, in which the deformities were most marked, and in the short pipe bones of the hand where there was very little actual deformity aside from the clubbing. Bessel Hagen believes that the bones are always shortened, while Niederle says they may be longer than normal and reports such a case.

In this case there is both central and peripheral involvement, the former manifesting itself as a very general diffuse enlargement of the long bones, the latter as typical exostoses arising from the cortex of practically all the long bones.

The cystic formation which is present in practically all of the lesions is a most striking feature and apparently unusual, since Borchardt and others have described such cysts as being isolated lesions and rarely multiple. Whether these areas of cystic degeneration can be considered as true bone cysts is a question. They are doubtless formed by the degeneration of the cartilaginous overgrowths. Virchow, in 1876, first described such a condition in the upper end of a humerus, where there was no bone expansion. He described the cyst as being lined with fibrocartilage and fibrous connective tissue. Bloodgood, in his contribution on bone cysts, considers true central enchondromata extremely rare and finds only four such cases with cysts since the original observation of Virchow and considers these as accidental findings, with no relation to true bone cysts. The most of Bloodgood's cases of bone cysts had a definite relation to osteitis fibrosa of von Recklinghausen and Paget, but this is an inflammatory condition; it may be the result of

trauma and its origin is never in cartilage. All of these features are quite at variance with the findings in our patient. Anschutz, in the report of a case of enchondroma, dwells at some length on the differences between these two conditions.

Cystic degeneration has also been observed in a variety of other bone lesions; among them may be mentioned central sarcomata, myxomata, arthritis deformans, callous cysts and subperiosteal hæmatomata.

Sections from the single tumor which was removed in our case are consistent with the view that in this condition we have the result of an abnormal and misplaced growth of cartilage, which has undergone cystic degeneration.

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**A PRELIMINARY REPORT ON A STUDY OF THE PROTECTIVE FERMENTS OF THE BLOOD BY THE ABDERHALDEN METHOD, AFTER THE TRANSPLANTATION OF ORGANS\***

**BY CHARLES GOODMAN, M.D.**

**OF NEW YORK**

At the recent meeting of the International Congress of Surgeons, Carrel reiterated his former statements to the effect that he had met with considerable success in autotransplantation but that homotransplantation of an organ, such as the kidney, was only temporarily successful, it invariably showing degenerative changes within a few days. Lexer, on the other hand, showed that he had succeeded in overcoming some of the biochemical reactions between his animals by a prolonged preliminary treatment of the host with tissues and blood serum taken from the donor.

Blood-vessels transplanted with proper precautions retain their vitality, become an integral part of the system and are believed to remain without extensive tissue metamorphosis.

But when parenchymatous organs with a more complicated physiological function, such as the kidney, the spleen and the thyroid, are transplanted the results as stated are different. They soon undergo autolytic changes and eventually become absorbed. This is known to be caused by biochemical reactions but may be due in part to injury incident to deficient venous drainage, and the technic about to be described is thought to minimize such injuries.

For an interval after an organ is transplanted, it remains in a state of vasomotor paralysis, and is apt to become overdilated with blood on account of insufficient venous drainage. Before appreciating the value of and employing end-to-end anastomosis I had found it necessary to split the kidney capsule in order to prevent parenchymatous destruction by hypertension.

In transplanting the kidney of one dog to the neck of another, one may unite the renal artery end to side to the carotid, but the stoma of the renal vein (Figs. 1, 2 and 3) should be placed end-to-end with that of the external jugular. This I consider very important, because it creates immediate venous drainage for the transplant on account of the

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\* From the Laboratory of Experimental Surgery, New York University.

negative pressure in the jugular. Such positive drainage does not occur if the anastomosis is lateral.

The Abderhalden method was used to seek the protective ferments in the blood which are brought into activity by the presence of a foreign transplant and which may induce its final autolysis.

The thyroid, on account of its accessibility and of the ease with which slight degenerative changes may be recognized, was chosen as the organ to transplant in this study. Furthermore, its venous drainage may be made adequate to prevent hypertension, thus minimizing parenchymatous changes due to physical injury (Fig. 4).

Thyroid transplantation had been undertaken by Borst and Enderlein, Stich and others. Stich in his series of experiments had two successful autotransplants. Of my autotransplants, in two consecutive instances, the thyroid having been removed from the body and reimplanted in the same animal, the results were satisfactory, the thyroid tissue retaining its normal appearance and, apparently, its activity (Figs. 5, 6 and 7).

In a series of homotransplants, although several of the animals lived for some time, the transplant invariably underwent degenerative changes with absorption (Figs. 8 and 9). From a series of fourteen specimens so far obtained at the Laboratory of Experimental Surgery at the New York University, work conducted through the courtesy of Dr. George D. Stewart, it has been possible in eight instances to demonstrate the presence in the blood of a protective ferment capable of digesting suprarenal tissue. The significance of the demonstration is problematical but it may be an index of the susceptibility of the suprarenal body to insults occurring anywhere in the hæmopoietic system. However this may be, the Abderhalden reaction was positive in eight specimens from dogs operated upon as above described.

Tests with different substrata are being made to determine whether organs other than the suprarenal are sensitive to a thyroid transplant.

It is hoped that a way may be found, perhaps with the aid of the X-ray in controlling lymphatic absorption, to modify the biochemical differences which at present cause autolysis and prevent the use of transplants in applied surgery.

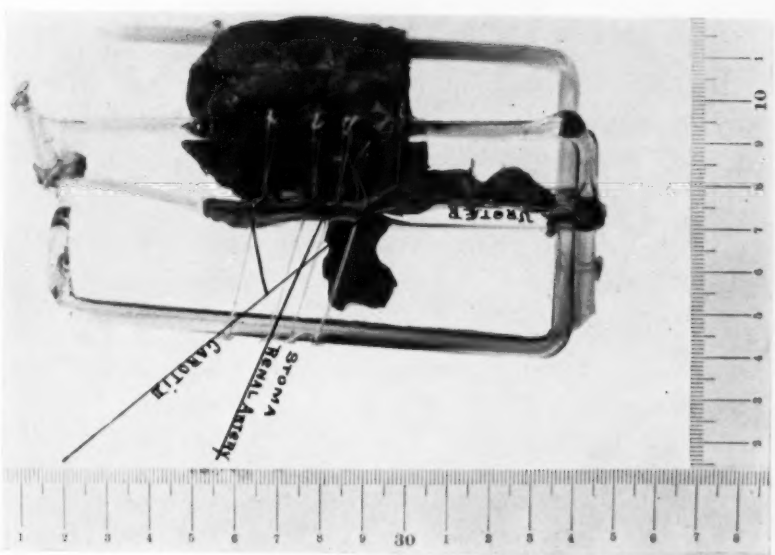


FIG. 1.—1c. Homotransplant of kidney.

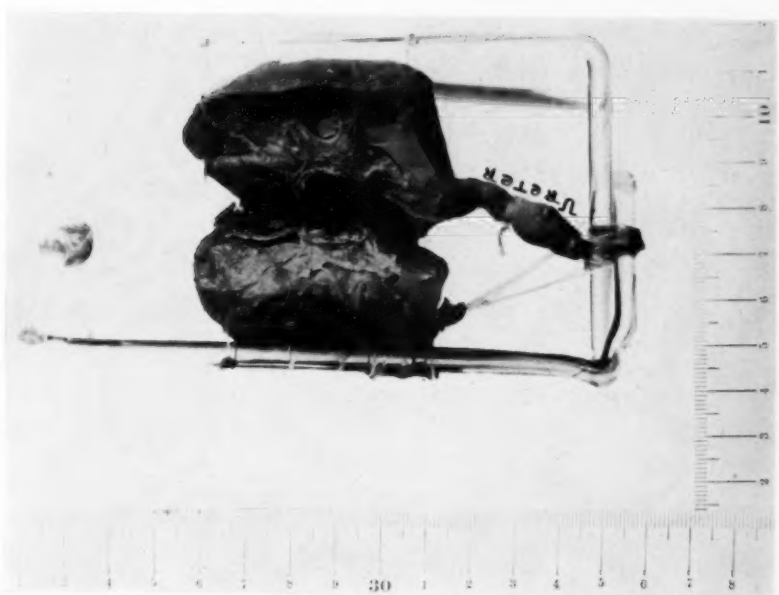


FIG. 2.—1b. Homotransplant of kidney.



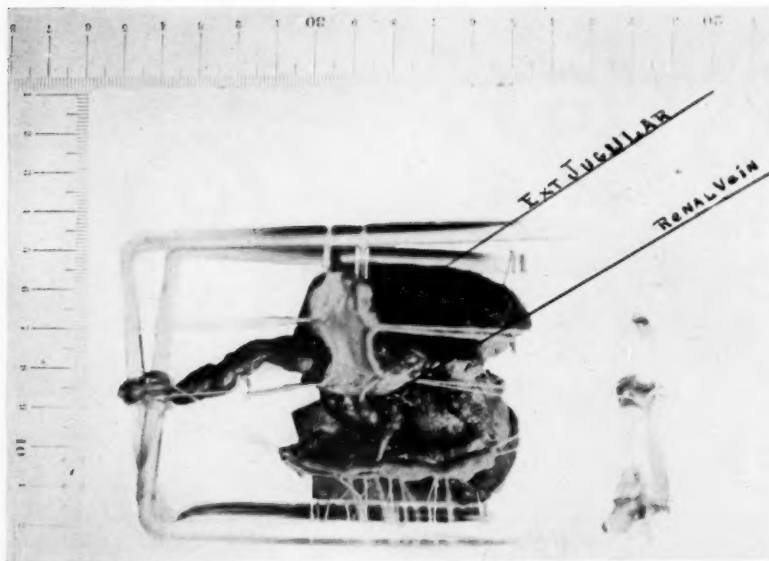


FIG. 3.—1a. Dog 765, host. Dog 685, donor. Homotransplantation of kidney to neck. Terminolateral anastomosis, left renal to right carotid; end to end renal vein to external jugular. Removed 8 days post-operative. Note difference in calibre of vessels.

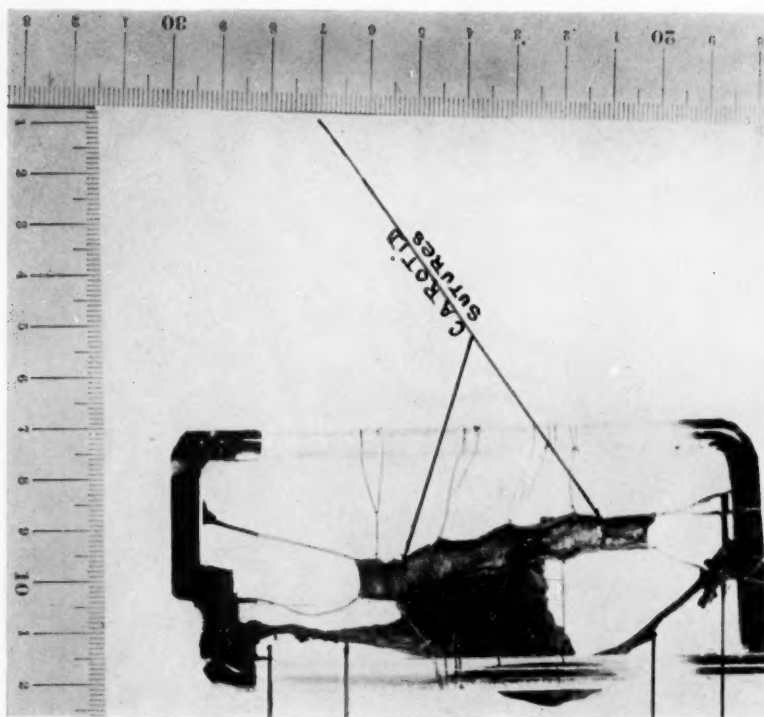


FIG. 4.—Dog 185, moribund black medium sized mongrel, donor. Dog 208, Irish terrier, brown mongrel, host. Homotransplant of thyroid, April 9, 1914. Segment of left carotid of dog 185 interposed between severed ends of right carotid of dog 208. Inferior thyroid vein end to end with left external jugular; superior thyroid vein end to end with right internal jugular. Dog died fifth day, hemorrhage.

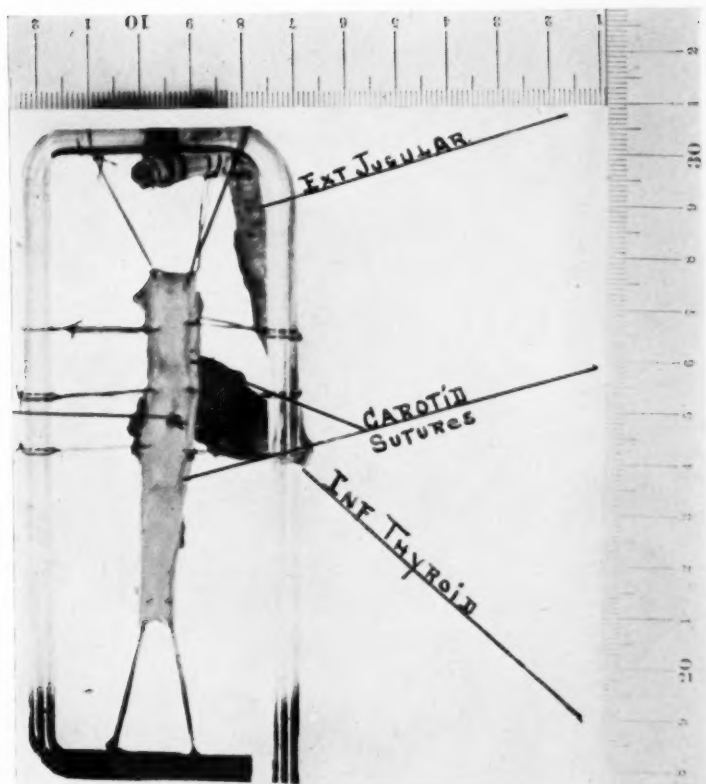


FIG. 5.—Dog 132. Autotransplantation of thyroid, February 26, 1914. Right thyroid with segment of carotid transplanted to left side. Inferior thyroid vein end to end with right external jugular. Removed twenty-three days after operation. Pathological report, normal gland.

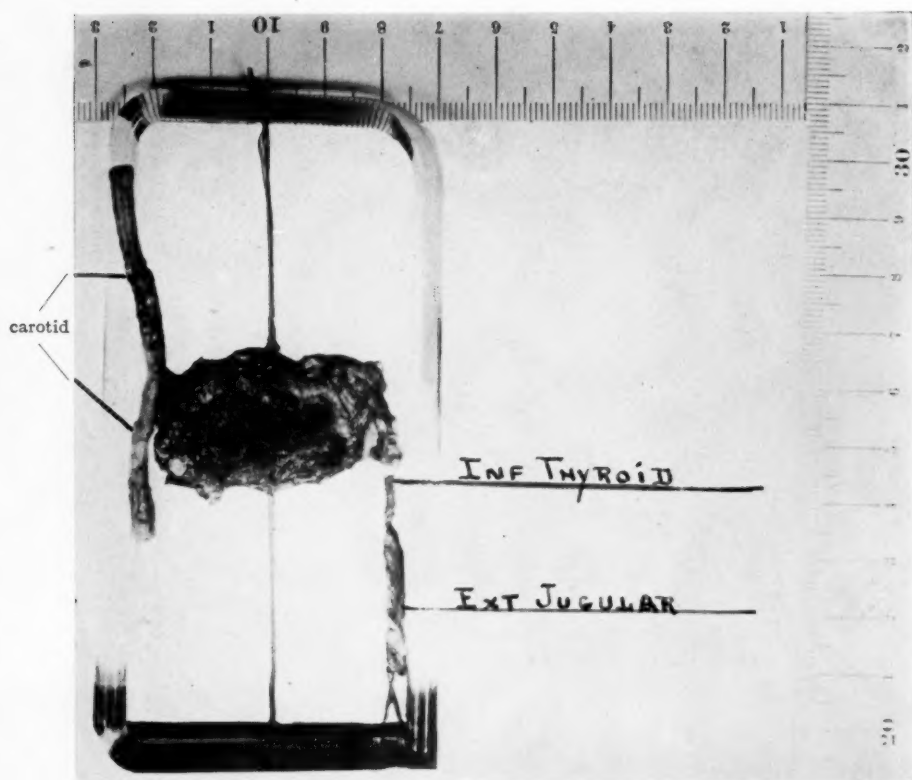


FIG. 6—Dog 138. Autotransplant thyroid, March 2, 1914. Thyroid with segment of right carotid interposed between ends of severed left carotid, right inferior thyroid vein end to end with external jugular. Death due to pericardial hemorrhage, following aspiration of the left ventricle.

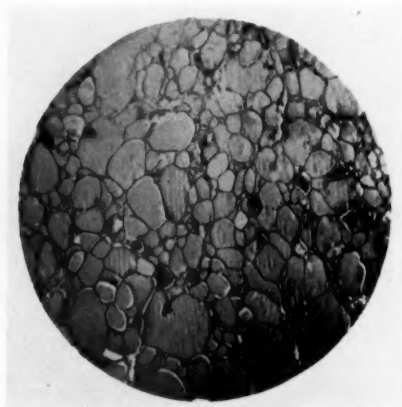


FIG. 7—Dog 132. Autotransplantation of thyroid; specimen removed twenty-three days after operation.

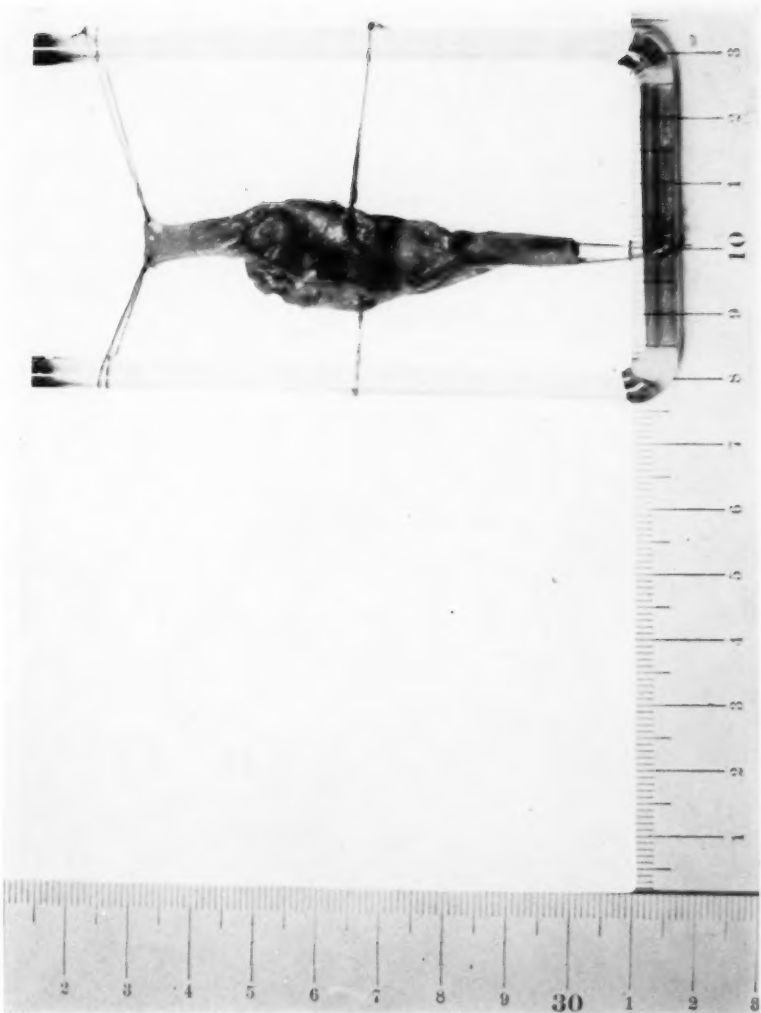


FIG. 8.—Dog 163, donor. Dog 164, black and white coon, mongrel, host. Homotransplant, March 19, 1914. Specimen removed April 23. Gland shows partial absorption. Carotid has smooth intima. No thrombosis.

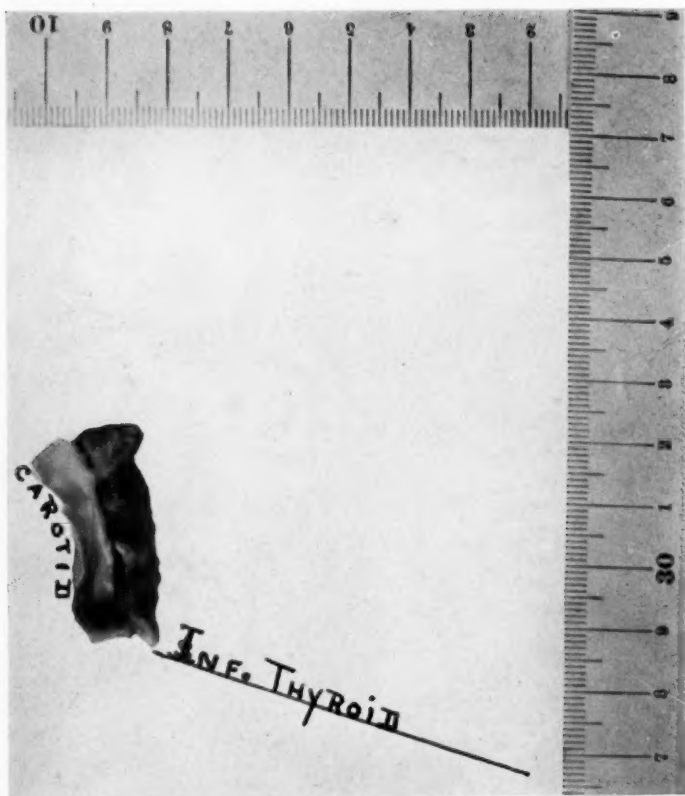


FIG. 9.—Dog 156, black and white bull, donor. Dog 157, mongrel host. Homotransplant of thyroid, March 16, 1914. Microscopic report—partial necrosis; no thrombosis.



ILLUSTRATIONS DEMONSTRATING THE VARIOUS STEPS IN THE TECHNIC EMPLOYED IN THE TRANS-  
PLANTATION OF THE THYROID IN A DOG.



FIG. 10.—Exposure of thyroid body.



FIG. 11.—Thyroid isolated with vessels ready for removal.

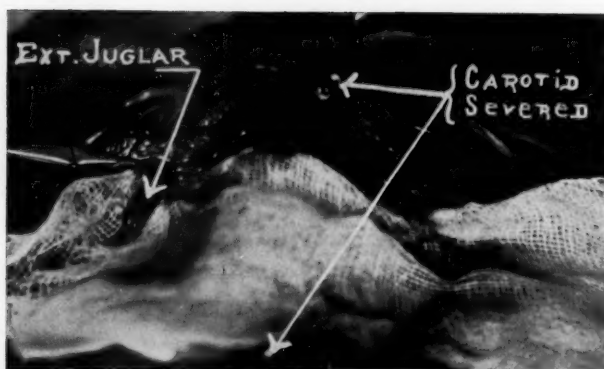


FIG. 12.—Carotid and external jugular of host prepared for reception of transplant.

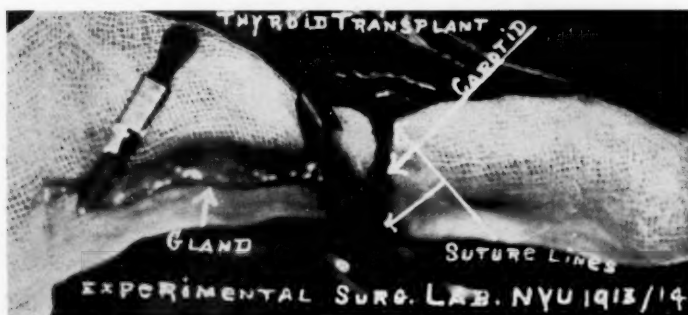


FIG. 13.—Carotid suture completed. Serrefines on thyroid vessels to prevent contamination of operative field.

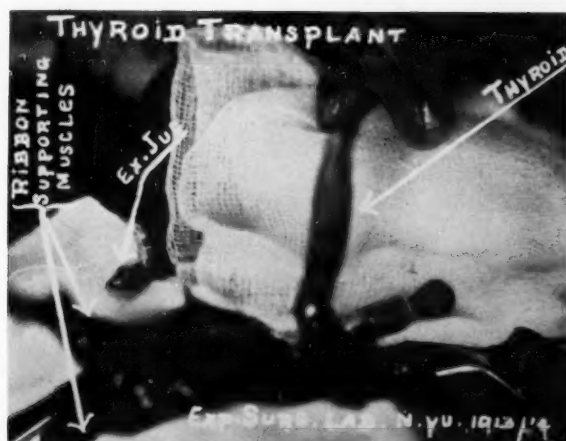


FIG. 14.—Muscles in front of trachea tunneled and raised to admit transplant.



FIG. 15.—Suture of thyroid end-to-end with external jugular of opposite side, completing transplantation.



## SPINA BIFIDA

AN EXPERIMENTAL AND CLINICAL STUDY

BY NORMAN SHARPE, M.D.

OF NEW YORK

(Published from the Laboratory of Experimental Physiological Surgery of New York University and Bellevue Hospital Medical College)

SPINA BIFIDA, that curious congenital anomaly, has from time to time for many years engaged the attention of surgeons and embryologists. As yet the cause or causes of this condition are still unproved. The majority of embryologists unite in declaring that the chief factor, if not the only one, is a failure of the mesoblastic plates, in which the bony laminae of the spine are developed, to close over the spinal canal, thus leaving a gap or defect. This lack of development they regard as the primary causative factor of spina bifida. In opposition to this theory the suggestion has been advanced at different times, usually by surgeons, that the lack of development of the mesoblastic tissues is not the primary cause, but is secondary—is a result. They suggested that the primary, or inciting factor, is an abnormal accumulation of cerebrospinal fluid, in early fetal life, which by exerting pressure prevents the coming together of the mesoblastic plates containing the rudimentary laminae, in this manner producing a gap or defect in the spinal canal.

Several other theories have been advanced, none of which have received much support. They will be mentioned later.

The adherents of the first theory have advanced facts, marshalled arguments and presented the results of many experiments in their efforts to find the causative factor. But this is not yet definitely settled. The writer is one of those who believe that the second theory mentioned is the true one—that is, that the primary cause of spina bifida is the excessive pressure exerted by an abnormal amount of cerebrospinal fluid, this pressure preventing the closure of the bony laminae. And he believes that the results of later experiments are tending more and more strongly to throw the weight of evidence in favor of this theory.

It is proposed in this article to discuss the various theories of spina bifida, to give the results of experiments in connection with this subject carried out by the writer in the Laboratory of Experimental Surgery of New York University and Bellevue Hospital Medical College, besides a short review of the different varieties of spina bifida with their symptoms, diagnosis and treatment.



ETIOLOGY.—In view of the difficulties confronting the experimenter, in that spina bifida originates in early fetal life, and that it is impossible to confirm on a human subject the results of experiments on the lower vertebrates, it is unlikely that the cause of this curious condition will be found directly through experiments.

Of the various theories that have been put forward concerning the cause or causes of spina bifida, those which have received but slight support will be discussed first.

*Amniotic Adhesions.*—According to those who put forward this theory, the amnion becomes adherent to certain points along the dorsal ridge, and by traction prevents the mesoblastic tissues from crossing over and covering in the medullary groove. It is not explained how the amniotic bands selected the lumbosacral region, where by far the greater number of spinal defects are found. Besides, Dareste<sup>1</sup> and many others have, by chemical means, produced spina bifida in the embryos of amphibians, and these have no amnion. Mall<sup>2</sup> asserts that amniotic adhesions are the results of malformations, and not the cause of them.

Another theory advanced is that a *tumor* in the central canal of the cord, or in the spinal canal, in early fetal life, by its mere presence, prevented the laminae from coming together and closing the canal. Tumor masses, especially lipoma, are frequently found in the cleft in spina bifida occulta, but almost never in the other forms of spina bifida. Nor does this theory explain rhachischisis, and it has been given but slight support.

According to another theory, *kyphosis* of the spine, caused by exaggerated curvatures of the fetal vertebral column, so interferes with the development of the cord that spina bifida is the result. But as these exaggerated curvatures occur usually in the cervical and dorsal regions, it does not account for the majority of spina bifida being found in the lumbar and sacral regions. Neither does it explain spina bifida anterior, nor the fact that the cord in a great number of cases is fully developed.

The theory that has received the greatest support up to the present, especially from embryologists, is that spina bifida is due merely to lack of development of the mesoblastic tissues that cover in the medullary groove.

The Committee on Spina Bifida of the London Clinical Society in 1885<sup>3</sup> stated: "The theory which best explains the pathological anatomy of spina bifida is that which assumes a primary defect of development of the mesoblast from which the structures closing in the vertebral furrow are developed. After the closure of the neural furrow it would appear that the processes of mesoblast which subsequently insinuate themselves between the primitive spinal cord and

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its overlying epiblast are formed in an insufficient degree to meet and combine, or that these processes, should they meet, are not formed in sufficient proportion to serve as a basis, from which the various structures subsequently to be produced over the spinal cord can be developed." This theory, in the main, is supported by embryologists, being merely modified in some respects by the results of experimentation. Bailey and Miller<sup>4</sup> say that "at the present time it is generally agreed that spina bifida is closely related to defective closure of the neural tube, although the exact nature of this relation is not known."

Hertwig<sup>5</sup> showed that if the eggs of axolotl are treated with a 0.7 per cent. solution of sodium chloride, all the embryos will have spina bifida; and Morgan and Tsuda,<sup>6</sup> by putting frog embryos in the early stages into a 0.6 per cent. solution of sodium chloride, produced spina bifida.

Recently some embryologists are abandoning the idea that spina bifida is due to lack of development of the mesoblast; to a germinal defect. They state that these experiments indicate that malformations are due to external influences, and not to defects in the germ itself. Mall says that malformations are not due to poisons in the maternal blood (corresponding to chemicals used in experiments) or to germinal defects, but to faulty implantation of the ovum in the uterine mucosa, or to an unhealthy condition of the mucosa.

In opposition to these theories, from time to time the opinion was advanced, mostly by surgeons, that the primary cause of spina bifida was some disorder of the cerebrospinal fluid circulation. But owing to the former scanty knowledge of the formation and outgo of this fluid, progress in this direction was hampered. Recent investigations in this field, however, have opened up this subject widely. We now know that the cerebrospinal fluid is a secretion, and not an exudation, and that it is formed by the choroid plexuses of the lateral ventricles. The remarkable work of Dandy<sup>7</sup> in stopping the outflow of fluid from the ventricles by plugging the iter, and injecting solutions of phenolsulphone-phthalein into the ventricles, and in other cases into the subarachnoid space, and timing its appearance in the urine, shows that the cerebrospinal fluid is removed or absorbed almost entirely by the blood-vessels of the subarachnoid space, to a very slight degree by the lymphatics, and practically not at all by the ventricles.

The writer believes that the vast majority, if not all, of spina bifidae are caused by the pressure exerted by an excessive secretion of cerebrospinal fluid, or, what is more probable, some obstruction to its normal outflow. This pressure, acting in early fetal life at different stages of development, prevents the closure at certain points of the bony canal. This theory is applicable to all forms of spina bifida, and has the support of much clinical evidence. This theory should not be confused with the opinion expressed by Förster many years ago, that spina bifida was due to dropsy of the central canal of the cord, which forced out a pro-

trusion through the posterior columns of the cord, causing atrophy of the nerve fibres. Except for syringomyelocoele, which forms only one or two per cent. of all cases, this is now held to be incorrect, as in the great majority of cases the central canal is normal, and in many the nerve fibres are intact.

What are the facts on which rests the theory of intradural pressure? We know that the cord is derived from the epiblast, as is also the skin. These two structures, the cord and skin, remain adherent, until the mesoblastic structures (meninges and bone) insinuate themselves between the cord and skin, which occurs normally in the third month of fetal life.

The vertebræ are developed from four centres of ossification, one for each lamina and one for each half of the body. The laminae meet in the median line, closing the spinal canal first in the dorsal region, then in the cervical, and last in the lumbosacral regions. The choroid plexuses of the cerebral ventricles are formed by the second month of fetal life, so that the cerebrospinal space contains fluid before the cord and skin are separated by the mesoblast, which should occur in the third month. Therefore, any undue pressure in the spinal canal at this time will prevent the closure at some point of the canal; and it is clear that this point will be the region of latest closure, the lumbosacral region. This is the region favored by spina bifida, in which, according to observations, 86 per cent. of all spina bifida are found; while  $9\frac{1}{2}$  per cent. are found in the cervical, and  $4\frac{1}{2}$  per cent. in the dorsal, the region of earliest closure of the canal.

Even in total rhachischisis with only rudimentary development of the cord and brain, the ventricles and choroid plexuses are fully developed, showing that fluid has been secreted; and excessive secretion with distention at this early stage will account for the rudimentary brain and cord and its open condition.

What are the clinical facts that support the theory of undue subdural fluid pressure, or that oppose the theory of germinal defects or lack of development? As against the theory of lack of development in the mesoblast, we have those cases in which after the protrusion is excised, thus removing pressure, the rudimentary laminae will take on new growth, as reported by Patterson.<sup>8</sup>

Supporters of the germinal defect theory assert that the increased amount of fluid present, as shown by the hydrocephalus that so commonly accompanies spina bifida, is a secondary condition, a result of the open canal. This is disproved by those cases where there is no bony defect, but the protrusion is forced out through the intervertebral

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ligaments. Also, hydrocephalus does not follow craniotomies or decompression operations, done on very young infants, and yet hydrocephalus will very often develop in children with spina bifida *after* the defect is closed. My own opinion is that the conditions causing the excess of fluid in fetal life still exist after birth, but much of this fluid is removed by the rich vascularization to be seen around the sac, the dura being absent or open in most of these cases. Where the dura is not open, or where hydrocephalus does not follow the operation, is explained by renewed function of the vessels of the subarachnoid space. The series of experiments undertaken by the writer were not done with the expectation of discovering the cause of spina bifida, but rather with the view of discovering evidence for or against the theory of undue intradural pressure. Naturally, it is admitted that producing spina bifida or a condition analogous to it, on a living animal by means of pressure, is not positive proof that spina bifida in the human being is produced by this means, any more than producing spina bifida in frog embryos by treatment with sodium chloride solutions is proof that spina bifida in the human being is caused by chemical stimulation. Experimentation along this line can but add corroborative evidence to clinical facts. Very young dogs were selected and lumbar laminectomies were done, only the superficial tissues being sutured over the defect. Large areas of the skull were removed and wounds allowed to heal. Then pressure was applied to the head, maintained and gradually increased. It was not expected that the external pressure alone would be sufficient to cause a protrusion in the lumbar defect, as even in very young dogs the dura is rather inelastic, but it was hoped that the irritation of the pressure on the cortex would cause an increase in secretion of the cerebrospinal fluid, or, what was equally as efficient, an obstruction to its normal outflow. That this did happen in some of the subjects was shown by the development of oedema of the optic nerve head, which gradually progressed to choked discs with dilated retinal veins, as noted by the ophthalmoscope. This was not due to the external pressure alone, as other dogs, on which as great or greater pressure was used, showed no oedema of the discs. Although the pressure in no case was sufficient to paralyze the dogs, yet in two of them, the one with the choked discs and one other, autopsy showed marked bulging of the spinal membranes through the laminectomy cleft.

The same procedure was carried out on one guinea-pig and two rabbits, with this difference, that injection of salt solution was used to create the pressure, instead of external pressure over a craniotomy wound of the head. Rabbits and guinea-pigs were selected because of



their less strong and dense meninges. The technic was the same in all three cases, and the same results were secured. The laminae of the last two lumbar and of the first and second sacral vertebrae were removed, exposing the dura. Then the laminae of the last cervical vertebra was removed and by means of a syringe with hollow needle two drachms of salt solution were injected under the membranes. This increase of intradural pressure caused a marked protrusion of the membranes through the cleft in the lumbosacral region. Fig. 1 shows the artificial spina bifida produced in the lumbosacral region of a rabbit and Fig. 2 is a diagrammatic view of the same condition. Naturally these experiments do not prove the cause of spina bifida. They merely show that intradural pressure, whether applied over a period of weeks, as in the case of the dog, or for a few minutes, as in the case of the rabbit, will cause a protrusion of the spinal membranes if there be a gap or defect in the bony canal. They are evidence, not that spina bifida is caused in this manner, but that it could be. In the writer's opinion, further advances along this line of investigation will be made as more facts are uncovered concerning the disorders to which the cerebrospinal fluid circulation is subject.

VARIETIES OF SPINA BIFIDA.—*Rhachischisis*.—This, the most extreme form, differs from spina bifida proper, in that in it the cord is spread out and exposed and the central canal is open, while in spina bifida proper the cord is covered and the central canal does not open on to the surface. Rhachischisis may be either total or partial.

In total rhachischisis, the pressure being exerted very early in intra-uterine life, the entire medullary groove remains open, so that the entire canal is uncovered; the skin, bony arches and meninges are absent. The lining of the central canal of the cord is open and the layer of pia containing blood-vessels is exposed. Anacephalus sometimes accompanies this condition, so that from the forehead to the coccyx the spinal canal is simply a trough containing the mass of undeveloped brain and cord. The spinal column is usually disposed in abnormal curves, especially in the dorsal and cervical regions. Thorndike,<sup>9</sup> who has studied this condition, presents several typical and interesting specimens of this character.

In partial rhachischisis or, as it is termed by some, myelocoele, only a part of the spine and cord are involved, usually only three to five vertebrae. At the site of the defect, the cord with its central canal is open, and the spread-out layers of pia carrying blood-vessels gives to this area, which Von Recklinghausen has called the "area medullovasculosa," the appearance of mucous membrane. In milder forms of partial



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rhachischisis the defect is covered by a thin membrane, the central canal opening into the surface at the upper and lower ends of the gap, with leakage of cerebrospinal fluid.

Both total and partial rhachischisis are easily recognized. They are of little interest from an applied surgical point of view, as the infants are usually stillborn, or at best live but a few hours or days. The case of partial rhachischisis with recovery reported by Small<sup>10</sup> is a doubtful one, as nothing was said as to the condition of the cord or that the central canal opened into the surface.

*Myelomeningocele*.—This is the most frequent type of spina bifida, occurring in 70 to 80 per cent. of all cases. In this type of spina bifida the cord is almost fully formed, but the abnormal pressure prevented the crossing over of the mesoblastic tissues, so that the cord and skin are not entirely separated. Hence, when the skin is forced outward to form the sac wall, the adherent cord and roots are drawn out of the canal. Myelomeningocele is commonly found in the lumbar region, infrequently in the dorsal, and rarely in the cervical. Fig. 3 is a myelomeningocele at the lumbosacral junction, accompanied by mild hydrocephalus. At operation eight roots of the cauda equina were found adherent to the sac wall. There is a fairly large bony defect, and these tumors are always sessile. The base of the sac is composed of normal skin, but the apex is covered by a membrane formed by the fusion of epithelium with the arachnoid and pia. This membrane may be quite strong, but is usually thin, and contains small ulcerating areas, through which cerebrospinal fluid "sweats." At the junction of this membrane with the skin base, there is a ring of connective tissue containing plexuses of blood-vessels and at times the rudimentary laminæ. The protrusion is usually unilocular, but occasionally small cavities are found communicating with the main sac. The summit of the sac is often marked by a dimple at the point where the cord is attached, or if the defect is in the lower lumbar region, by a broad furrow marking the attachment of the conus terminalis. Due to the traction of the adherent cord and roots, or to lessened intradural pressure, the entire summit of the protrusion is often cup-shaped. The dura is absent in the defect, extending only to the membranous-skin junction, or even only to the margins of the bone defect. Rarely myelomeningocele is unaccompanied by nerve disturbances, but the following are more often found: Partial paralysis of the legs or complete paraplegia, club-foot, trophic ulcers, incomplete control of the sphincters and often incontinence.

The diagnosis of spina bifida is, as a rule, not difficult, if the following points are kept in mind—that the protrusion is congenital and is in

the median line; that there is fluctuation of the sac, and pressure causes a decrease in size with bulging of the fontanelle; that the tumor becomes tense on coughing or crying; that the cleft in the bone may be felt; that the tumor is translucent.

Spina bifida in the lumbosacral region must be differentiated from the following conditions: Lipoma, post-rectal dermoid, and ischiatic hernia. The most common error is made in regard to lipoma. Lipoma often overlies a small spina bifida and operation to remove a supposedly simple lipoma may result disastrously for the patient (Bland Sutton<sup>11</sup>).

To differentiate between the different varieties of spina bifida is more difficult. In making a diagnosis of myelomeningocele we rely upon the following points: Myelomeningocele is the most common form, occurring in 70 to 80 per cent.; there is usually a fairly large bony cleft which can be felt; the tumor is sessile and has a membranous apex, which is dimpled or furrowed at the point of attachment of the cord or roots; transillumination will usually show the extruded cord and roots, but this sign often fails, owing to irregularities in the sac wall; and, finally, the evidence of nerve involvement of the lower extremities, which is very common in myelomeningocele.

Untreated, practically all these children will die, very few of them reaching the age of five years. Operated upon, the prognosis depends upon the general condition of the child, the condition of the sac and the amount of nerve involvement. There have been many cases of cure reported, most of them in young infants.

*Spinal Meningocele.*—Meningocele is found in from eight to twelve per cent. of all cases. It is commonly found in the lumbosacral region, infrequently in the cervical and rarely in the dorsal regions. The bony gap is usually a small one, involving but one or two arches. Occasionally there is no bony defect found, the meninges being forced out through the intervertebral ligaments. The protrusion is at times pedunculated and covered with normal skin (Fig. 4), though sometimes the apex contains a small membranous area. The inner sac wall is lined entirely with dura and contains only fluid, the cord and nerve roots not lying in the sac, but occupying their normal positions in the canal.

Meningocele, the simplest form of spina bifida, can be explained in this manner: The abnormal accumulation of fluid does not occur until some time in the third month of fetal life, after the separation of cord and skin by the mesoblastic tissues. The pressure finds its outlet at the point where solid closure is least advanced, the lumbosacral region. When the protrusion has a very slender pedicle, the opening into the canal may be obliterated by fibrous tissue.

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The diagnosis of spinal meningocele rests on the following: The sac has a fairly narrow base, but rarely pedunculated. It is usually covered entirely by normal skin. Transillumination shows the absence of nerve elements. Nerve supply of the lower extremities is entirely, or almost entirely, free from involvement.

The prognosis is good, if operation is performed, though frequently excision of the sac is followed by enlargement of the head. Untreated, the prognosis is bad, for, except in those few cases where the opening into the canal is occluded, the tumor increases in size, with rupture and septic meningitis as the result.

*Syringomyelocele.*—This very rare form of spina bifida is due to the pressure exerted by an abnormal amount of cerebrospinal fluid in the central canal of the cord, the pressure preventing the closure of the bony arches and forcing the posterior half of the cord out through the bony defect. Thus the inner sac wall is formed from the spread-out cord, with attenuation and atrophy of the nerve elements. Syringomyelocele is found usually in the lumbar region, rarely in the cervical. As the central canal of the cord in the lumbar region remains quite large almost until birth, a collection of fluid here with pressure readily accounts for the protrusion being found in this region.

In making a differential diagnosis of syringomyelocele from the other forms of spina bifida, its rarity must be taken into account. It occurs only in one to two per cent. of all cases. In translucency it resembles meningocele, as the attenuated nerve elements cast little shadow. In appearance and symptoms of nerve involvement, it closely resembles myelomeningocele. However, as operation is the treatment for both types, a positive diagnosis before the sac is opened is not of great importance. The prognosis of syringomyelocele if untreated is the same as for myelomeningocele, and with operation it is not as favorable as that for myelomeningocele.

*Anterior Spina Bifida.*—In this rare form, the protrusion extends forward between the two halves of the bodies of the vertebræ, which, as has been said, develop from two centres of ossification; or through an intervertebral foramen. In this type the sac is usually found in the abdomen or pelvis, and the sacrum is the part of the spinal column most often involved. As a rule, there is no posterior deformity of the arches, though Williard<sup>12</sup> reports a case in which there was both an anterior and posterior protrusion. Spina bifida anterior is almost entirely confined to females, though Grossman reports one in a male infant of ten months. It is a pure meningocele, though pressure or irritation may cause some nerve disturbances, usually of the motor nerves.

The diagnosis is exceedingly difficult unless there is also a posterior protrusion, or there is an accompanying nerve involvement, such as club-foot or paraparesis. The sac usually reaches a much greater size than could occur posteriorly without rupture, and it is usually mistaken for sarcoma or ovarian cyst. The presence of symptoms of nerve involvement of the lower extremities should prevent such errors. The prognosis is uniformly bad, as all cases operated upon reported to date have died. In the majority of cases it would have been most difficult to have successfully closed the opening into the spinal canal.

*Spina Bifida Occulta.*—In this curious and interesting form of spina bifida there is a cleft in the bony arches, but no protrusion. The absence of protrusion is accounted for by lessened intradural pressure or by rupture of the sac in early fetal life, the point of rupture being marked by a scar which is often found in the skin over the defect. The tissues over the defect are often the seat of a diffuse non-capsulated lipomatous growth, or the skin overlying it is wrinkled and pigmented and surmounted by a tuft of coarse hair. The presence of lipoma or of hypertrichosis is equally pathognomonic of spina bifida occulta. Occasionally, however, the overlying tissues are free of defects and the skin is normal and free of scars or hair. Very often a lipoma or dermoid lies in the bony cleft or in the spinal canal, connected by fibrous bands with another tumor outside the canal. Again, adhesions are often found connecting the skin and cord and roots, showing an imperfect separation of the two in fetal life. Nerve involvement is usually absent at birth, but with the growth of the child, the ascent of the cord drags upon the adhesions in the cleft, and more or less severe symptoms of nerve disturbances make their appearance in the lower extremities. These are, weakness of the legs, distortion of the feet, coldness and discoloration of legs, trophic ulcers and disturbances of the sphincters.

The diagnosis depends on the symptoms of nerve involvement, presence of lipomatous tissue or hypertrichosis over the lower spine, and on the X-ray.

The patient in Fig. 5 was a sturdy sailor twenty-four years of age, who complained only of tingling in the hands and fingers when the arms were hanging loosely. There were areas of hypæsthesia and hypalgesia on outer side of the left upper arm. The skin over the defect was normal; no hypertrichosis or lipoma was present. The X-ray (Fig. 6) showed a defect extending from the fifth cervical to the sixth dorsal vertebra (the arrows mark the upper and lower limits of the defect). There will be noticed in this picture and also in the other skiagraphs a spreading or broadening of all parts of the defective vertebræ, which I



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ascribe to the effects of the intradural pressure in the developmental stage. Dr. B. C. Darling, who has made a study of this condition from a skiagrapher's point of view, tells me he finds this "broadening" in all cases.

The child of four and a half years shown in Fig. 7 had spina bifida occulta in the lumbosacral region, with partial paraplegia and incontinence of urine from birth. No protrusion in back or hypertrichosis was present, but a diffuse lipoma over the sacral region. The X-rays (Fig. 8) show absence of the laminae of the fifth lumbar vertebra and the upper segments of the sacrum, with distortion of the sacrum and the pelvis. Fig. 9 is the skiagraph of the pelvis of a girl of nine years of age who had partial paralysis of the right leg with a congenital dislocation of the right hip and a dilated bladder with incontinence. There was a tuft of hair an inch long over the fifth lumbar vertebra, but no protrusion. Fig. 10 shows the defect in the laminae better, extending from the fifth lumbar vertebra to the fourth sacral segment, a case of spina bifida occulta.

It was formerly believed that congenital dislocation of the hip, club-foot, hare-lip, cleft palate and the other deformities that sometimes accompany spina bifida, were due to general lack of development, and proving that spina bifida was but a germinal defect. But club-foot and dislocation of the hip, as in the above case, are readily seen to be due to the defective nerve supply. They are consequences of spina bifida and not germinal defects. As for hare-lip and cleft palate, we know that cyclopia and non-union of the branchial clefts can be artificially produced in the lower vertebrates by interfering with their normal course of development, by chemical agents. And as the normal union of the frontonasal and maxillary processes depends on a normal development of the forebrain region, the pressure of an abnormal accumulation of cerebrospinal fluid in fetal life will account for these defects.

**TREATMENT.**—The treatment of spina bifida other than by operative interference may be dismissed in a few words. Ligation of the base of the sac, acupuncture and aspiration only hasten the rupture of the sac, and are no longer used. Injection of the protrusion with Morton's fluid, a solution of iodine, once widely used, usually results in death. Even if shrinkage of the sac followed the injection, if any nerve elements were present in the sac, further compression of these occurred. However, some surgeons still advocate the use of Morton's fluid. Open operation is coming more and more to be recognized as the rational and best method of treatment. By many surgeons operation is strictly lim-

ited to selected and favorable cases, without much nerve involvement. But in view of the fact that over 90 per cent. of these children will die in the first year alone, if not relieved, and that many cases of recovery following operation on apparently hopeless cases have been reported, the scope of operative interference should be greatly extended. The writer believes that the only contra-indications to operation are a bony defect so large that it could not possibly be repaired, and a condition of absolute paraplegia and complete loss of sphincteric control. Age is of no importance, as many cases of recovery are reported in very young infants, following operation.

A description of the operative technic and the after-treatment will be omitted here, as the writer has described them in detail elsewhere (Johnson's *Operative Therapeutics*, vol. iii). The following series of cases, which were operated upon in conjunction with Dr. William Sharpe, in the Neurological Surgical Department of the N. Y. Polyclinic Hospital, were selected for reporting as representing different types of spina bifida. They include myelomeningocele, meningocele and spina bifida occulta. I have not yet met with syringomyelocele nor spina bifida anterior.

It is interesting to note that in the majority of them there was an associated hydrocephalus.

CASE I.—*Spinal Meningocele with Hydrocephalus*.—P. M., age three months; full-term child; normal delivery. At birth large head noticeable, also lump on back size of English walnut, which at times became much smaller, leaving only a wrinkled pad of skin. Examination at three months showed head quite large and broad, with bulging forehead, and fontanelles tense. There was a protrusion the size of a small grape-fruit over the sacral region two inches from the anus. Definite weakness of the legs. Child rather stuporous, some difficulty in breathing.

*Operation*.—Thin-walled meningocele, no cord elements in sac. Inner sac wall sutured at margins of cleft, and fascia drawn over and sutured with three layers of chromic gut. Skin sutures of silk. Right ventricle was tapped through a small opening and four strands of No. 2 catgut were passed into ventricle and anchored under scalp for drainage. At conclusion of operation child was in fair condition. Temperature rose to  $107^{\circ}$  in twelve hours and child died. In this case, we probably attempted to do too much, but on account of the difficulty in respiration, we thought it unwise to defer the tapping of the ventricle to a later time.

CASE II.—*Myelomeningocele with Hydrocephalus*.—Baby N., age five months; first baby; full term; normal delivery. Small



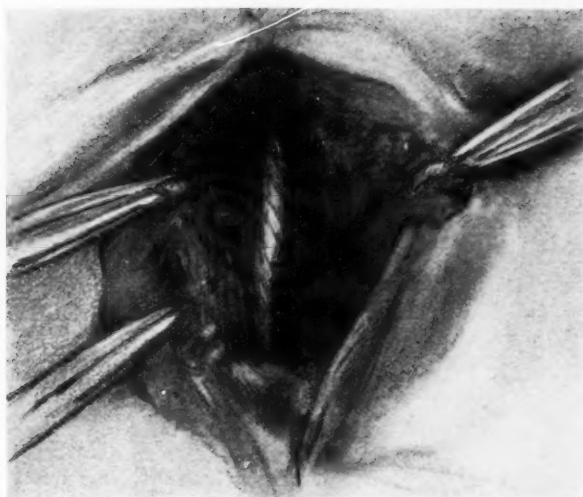


FIG. 1.—Artificial spina bifida in rabbit.

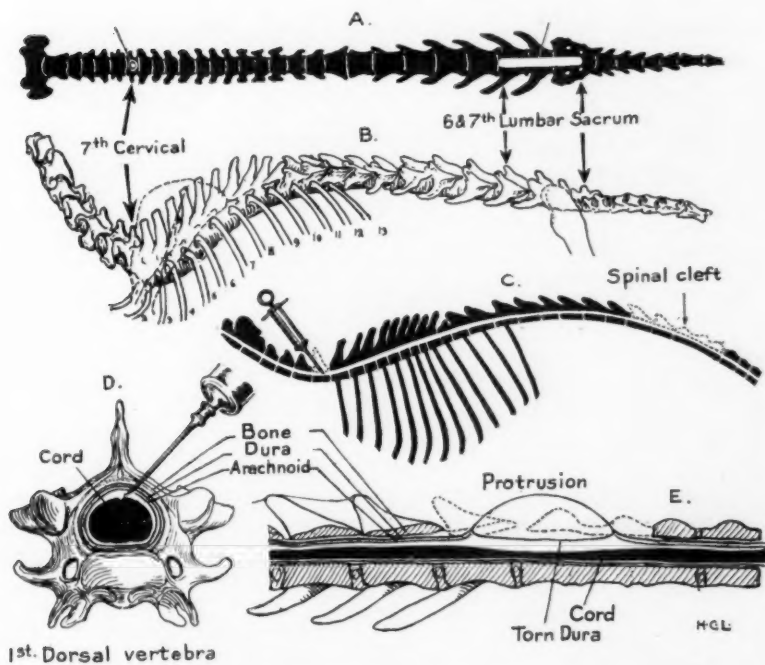


FIG. 2.—Diagrammatic scheme of artificial spina bifida.



FIG. 3.—Case II. Myelomeningocele with mild hydrocephalus.



FIG. 4.—Case III. Spinal meningocele with hydrocephalus.



FIG. 5.—Spina bifida occulta in cervicodorsal region.



FIG. 6.—Skiagraph of Fig. 5 (skiagraph by Dr. B. C. Darling).



FIG. 7.—Spina bifida occulta in lumbosacral region (after operation). A, line of incision.



FIG. 8.—Skiagraph of Fig. 7 (skiagraph by Dr. B. C. Darling).



FIG. 9.—Spina bifida occulta in lumbosacral region, with congenital dislocation of right hip. (Permission of Dr. Royal Whitman, skiagraph by Dr. B. C. Darling.)



FIG. 10.—Another view of sacrum in Fig. 9.



FIG. 11.—Case II. Myelomeningocele with hydrocephalus (after operation). Fig. 3 is same case before operation.



FIG. 12.—Case IV. Myelomeningocele (after operation).





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lump noticed at birth in lower lumbar region. This gradually increased in size. Legs apparently not affected. Examination at five months showed a well-nourished child with somewhat weak legs, but no definite paralysis. Slight weakness of rectal sphincter. In the lumbosacral region there was a reddish, thin-walled cystic tumor the size of a grape-fruit, with a wide base, three inches in diameter. Sac wall very thin at several points, rupture appearing imminent. Head was mildly hydrocephalic with high towering forehead (Fig. 3).

*Operation.*—A curvilinear incision was made along the left base of the sac. The lowered head of the child prevented the escape of cerebrospinal fluid other than that contained in the sac. Bone defect small,  $2\frac{1}{2}$  cm. in length. Eight roots of the cauda equina were found adherent to the sac wall. These were dissected free and returned to the canal which at this point was very shallow. The dura extending only to the bone margin, the canal was perforce left open. The vertebral aponeurosis was dissected up on each side and sutured over the cleft with several rows of chromic gut; skin sutures of silk. A rubber tissue drain was inserted. Child in good condition after operation.

Several days after operation several small trophic ulcers appeared on inner sides of thighs and on left big toe, probably due to operative injury to nerves in sac wall. They healed in a short time. At present, one year after operation, child is in good condition, the legs are strong and there has been no further enlargement of the head (Fig. 11).

CASE III.—*Meningocele with Mild Hydrocephalus.*—J. M., age four months; full-term child; instrumental delivery. Congenital protrusion the size of a lemon in lumbosacral region. No paralysis of lower extremities. Head apparently normal. Examination at four months showed a fairly well-nourished child with a thick, reddened tumor, orange-sized, over the fourth and fifth lumbar vertebræ. Tumor cystic in places. No paralyses, no sphincteric disturbances. Head slightly enlarged, but scalp vessels were greatly dilated and fontanelles tense (see Fig. 4).

*Operation.*—Straight incision in median line. Cord and nerve roots not involved in sac. Small laminal defect, through which a small cyst of arachnoid protruded (sac within sac). Base of sac ligated and overlaid by flaps from surrounding fasciæ, which was sutured with chromic gut; skin sutures of silk. Right ventricle tapped through the right margin of the anterior fontanelle. Much fluid escaped. Two weeks later the head had slightly enlarged, with fontanelles tense. Right ventricle was again tapped and ten days later this tapping was repeated. At present writing the child is in good condition. The head is still large, but not enlarging.

CASE IV.—*Myelomeningocele with Mild Hydrocephalus*.—A. H., age two weeks; full-term; normal delivery. Congenital cherry-sized swelling in lumbosacral region. Did not move the legs freely. Head not enlarged. Examination showed a well-nourished child with a reddened, tense swelling, orange-sized, over the first sacral vertebra. Sac wall very thin, with two yellowish excoriations at the summit. Head not much enlarged, but fontanelles very tense. Some weakness of right leg. Incontinence of urine and fæces.

*Operation*.—S-shaped incision opening sac. A number of cauda roots were found adherent to sac wall, dissected free and returned to the canal. Small bony defect in the first sacral segment. Inner sac wall sutured in the cleft and overlaid by flaps cut from the vertebral aponeurosis which were drawn one under the other, as in the repair of umbilical hernia. Skin sutures of silk. Superficial infection of wound from the dribbling urine and fæces. Daily dressings. Child discharged three weeks later in good condition. Five months later there was no paralysis, no incontinence; head slightly enlarged. A year later child was in excellent condition, no paralysis and head not enlarged (see Fig. 12).

CASE V.—*Myelomeningocele with Almost Complete Paraplegia*.—G. M., age one and a half years; eight-months child; normal delivery. Tumor in lumbosacral region size of walnut which ruptured at birth and discharged fluid for three days. Legs weak. Tumor gradually increased to orange size and was treated by caustics which caused it to shrink somewhat, with intense induration. Legs gradually became almost completely paralyzed, with incontinence of urine and fæces. Examination showed a fairly well-nourished child with paralysis of both legs and loss of sphincteric control of bladder and rectum. In the lumbosacral region was a reddened indurated mass the size of an orange. In the centre was a thinned area one and a half inches in diameter. No hydrocephalus.

*Operation*.—Straight vertical incision through centre of mass. Many nerve roots found bound in the scar tissue. Bony defect in the laminæ of the three lower lumbar vertebræ two and one-half inches long. Nerve roots were dissected free with much difficulty and delay and replaced in canal, and the tissues containing the rudimentary laminæ drawn together with chromic gut. Flaps from the lumbar muscles were resected and drawn over the cleft and sutured, with double row of gut. Skin with silk. Child apparently in fair condition but died in a short time after removal to the ward.

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The results obtained by the application of caustics to the sac (increase of paralysis) are identical with those following injection of the sac with irritants (Morton's fluid) if the protrusion contains nerve elements.

CASE VI.—*Spina Bifida Occulta with Paralysis of Legs*.—B. S., age four and one-half years; full-term child; normal delivery. Paralysis of legs not complete, from birth, and urinary incontinence. No rectal disturbance. Right leg more paretic than left. Examination showed at the lumbosacral juncture a diffuse lipomatous growth which extended over the left buttock (see Fig. 7). The prominence of the left buttock is due to the lipoma which extended over the cleft. No hypertrichosis. No defect could be felt in the spine, but the X-rays showed a defect in the fifth lumbar vertebra and the two upper segments of the sacrum, extending more to the left side (see Fig. 8). Legs markedly paretic, with marked atrophy. Knee-jerks absent. No Babinski. Sensation normal. Incontinence of urine.

*Operation*.—S-shaped incision (Fig. 7) over the defect as noted by the X-rays. Mass of fat overlying the defect and found in the cleft. Dura absent in the gap. Many adhesions found among the roots of the cauda, but no protrusion through the cleft. The adhesions found were removed and also the mass of tissue lying in the cleft. Lumbar fascia drawn over the cleft and sutured by double row of chromic gut. Skin with silk. Dressed daily. No infection. Three months later there was no improvement in paralysis or incontinence. Legs were somewhat larger and right knee-jerk was obtainable. Her present condition is about the same. In this case, contrary to that of Case I, we probably did not do enough, and a second operation is contemplated.

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## DEVELOPMENTAL RECONSTRUCTION OF THE COLON BASED ON SURGICAL PHYSIOLOGY\*

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EMBRYOLOGICAL development, extra-uterine growth, and physiological requirements fuse strikingly with other factors to elaborate lesion-characters and symptoms which are not alone typical and peculiar to the colon but essentially constant, easy of demonstration and of paramount vital value. Its origin, its growth and its work, then, must be of trenchant import to all who seek a knowledge of the great gut in disease.

In the earliest period of development, the vitelline duct or yoke sac, which later may result in Meckel's diverticulum, marks the dividing line between the fore- and the hind-gut (see Fig. 1). About the third week of fetal life there appears in the posterior limb of the U-shaped tube a diverticulum which becomes the future cæcum and appendix. Thus it is clear that a portion of the small adult bowel is embryologically identical with the great gut, and this explains in a measure the apparent vicarious assumption of colon function by the terminal ileum, which will be referred to in the clinical part of this paper.

Of course it must be understood by all that it is necessary to have a thorough knowledge of the physiology as well as the embryology to make deductions. For, though the organs are allied embryologically, it does not follow that their functions are also closely associated. The proposition we have enunciated does not hold good with organs that are highly specialized, such as the kidney and heart. It applies only to organs that are less highly specialized and older in function, such as the caudad ileum and colon.

A proper understanding of the various arrests or malformations that may occur in the caudad end of the gut, often resulting in disease, may be obtained by a knowledge of its development.

About the end of the third month a rotation takes place, and the cæcum comes into position over the right kidney (see Figs. 2 and 3).

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\* Studies from the Clinic of Gastro-Intestinal and Rectal Surgery of the New York Polyclinic Medical School and Hospital and from the Laboratory of Physiological Surgery of the New York University Medical School.

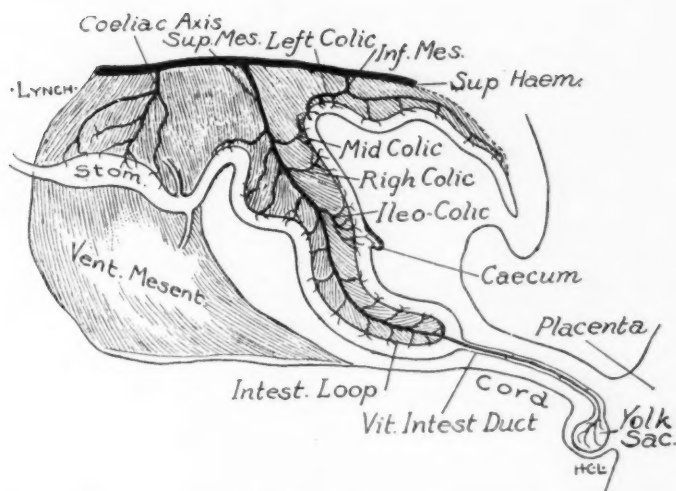


FIG. 1.—This figure shows the bud which appears on the posterior limb of the V-shaped tube, aboral to the vitelline duct. It shows not only that the transverse ileum and the colon have a common embryological origin, but that, at this period, the diameter of the small gut is greater than that of the large gut. (Keith.)

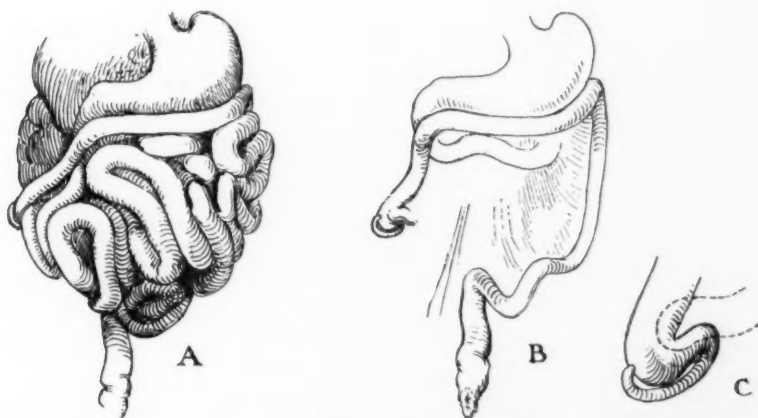


FIG. 2.—These drawings were made from a human fetus at three months. They show that the caecum occupies a position identical with that in the adult human after the operation for developmental reconstruction of the colon, namely, near the right kidney. Being drawn to scale, they also show the relative size of the large and small guts at this stage of development. (Lynch.)



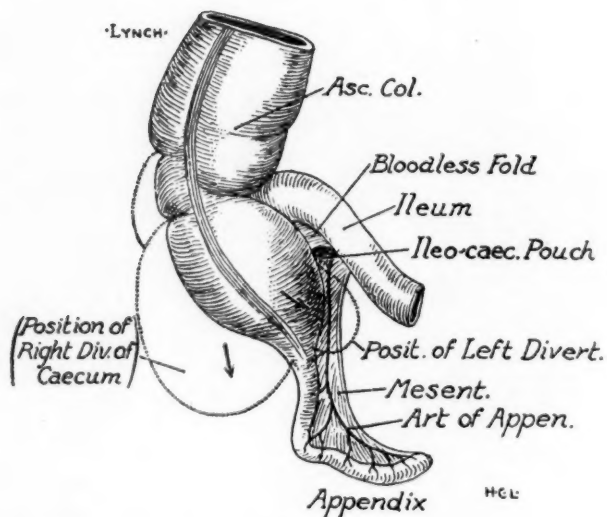


FIG. 3.—Development of the caecum, showing three primary diverticula and the primitive, funnel-shaped appendix. (Keith.)



FIG. 4.—This figure shows the extent of colon removed, and the relations to the middle colic artery. (Courtesy of D. Appleton and Company.)



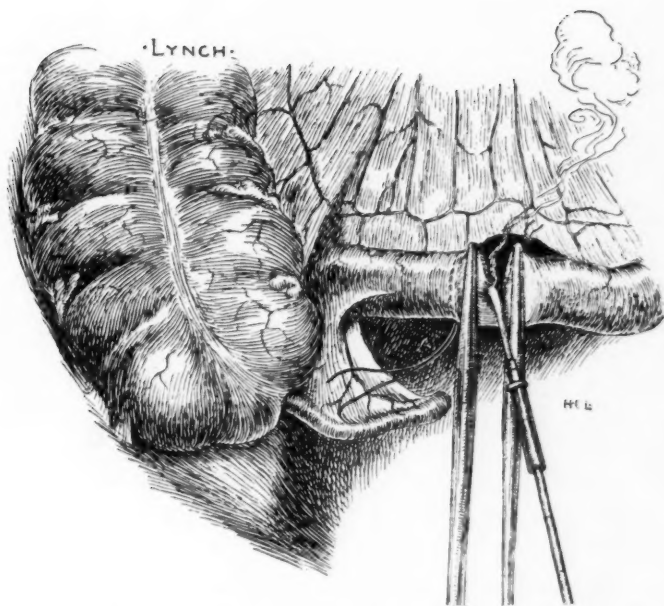


FIG. 5.—Resection of the ileum by cautery. The same technic is used on the transverse colon. (Lynch.)



FIG. 6.—Scale drawing of a latero-externally placed appendix, which was removed from Case No. 375. Note the funnel-shaped, embryonic type of caecum, and also the relation of this caecum and appendix to C of Fig. 2. Appendectomy failed to relieve the symptoms. Developmental reconstruction six months later has effected a cure. (Lynch.)



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In this, which has been called the second position, it rests until birth, when under *normal impulses* it gradually migrates to the right iliac fossa. In the dog, the second position is the final one, and in the light of recent studies in intestinal stasis it may very reasonably be questioned whether man would not have been much better adapted to the upright position and consequently more efficient, had the evolutionary process left his colon in the canine position. Certain it is that the operation of partial colectomy, the technic and value of which have been demonstrated by Bloodgood, and which has given such striking relief in a certain type of toxic cases, is nothing more than a reconstruction of the colon to the second or developmental position. Developmental reconstruction has been done by the authors in fourteen cases which afford basis for the clinical deductions presented. The technic of the operation can easily be followed by consulting Figs. 4 and 5.

Under *abnormal impulses* both the rotation and migration may be aberrant, with resulting malformations which are often accentuated by later growth. During the migration the appendix may be caught either posteriorly or laterally (see Fig. 6). These malformations evidently often lead to functional derangements, with consequent infection, inflammation, ulceration, pericolicitis, or new growth. In direct sequence may here be cited the clinical history of the J. family. Of seven children, four have been operated on for chronic appendicitis. Of the three remaining children, one has definite symptoms, one indefinite symptoms, one has no symptoms. A month ago the mother, aged sixty-four, who had been a chronic dyspeptic all her life, came to an emergency operation and a retroperitoneal purulent appendix was found. This is by no means an isolated instance of the occurrence of appendicular trouble in families, and Satterlee has called attention to the hereditary element in ptoses, of which appendicitis is so frequent a complication. This suggests the application to clinical study of the well-known law of heredity that, while acquired malformations are never inherited, the congenital forms are apt to be. In the type represented by the J. family, therefore, an explanation based on hereditary misdirection in the cecal migration from the second to the third position is as reasonable as is the assumption of an hereditary factor in the narrowing of the costal angle, which is an outward manifestation of ptosis, and which has been found accompanying the ptosis cases cited by Satterlee. Rovsing has called attention to the frequency with which the hereditary element is encountered.

Professor Stockard has furnished us with a specimen of intestine, from a man forty years old. The total length from stomach to anus was ninety-six inches. Nature had so beautifully maintained the balance in

this case, that the circumference was found by measurement to be directly proportionate to the length.

The *function* of the colon is dual: *elimination* and *absorption*. Elimination is purposely placed first, for the reconsideration of the older physiological teaching has already come to be of great concern to surgery. Brown and Blake and Draper have shown that in dogs the doubly excluded and occluded colonic segment will fill to bursting within a few days, even if very carefully cleaned before occlusion. It is thus a pertinent question what to do with partially excluded colonic segments in human beings. Until recently this function seems to have been looked upon chiefly with academic interest. One usually and naturally associates the colon with its most evident function, that of fecal storage and discharge, overlooking its fundamentally important attributes. This attitude is not directed particularly toward the colon, but coincides with the general viewpoint regarding other matters of surgicophysiological importance as, for example, the "biliary" function of the liver and the so-called "digestive" activity of the stomach. In each the evident and supposedly important function has completely overshadowed the less evident. But the subtle cryptic functions are proving to be the very ones of greatest value to surgery and only through their interpretation can the crude applied art of to-day hope to become the finished science of to-morrow. And we are rapidly learning that only what is biologically true is of fundamental therapeutic worth. Intestinal obstruction is illustrative of this, the only therapeutic measure of any clinical value after a mechanical release of the contents from obstruction having been found through biological studies. This interesting and little understood condition is also illustrative of the importance of the eliminative function of the colon, it having been shown that, in dogs dying of obstruction, the colon was characteristically hemorrhagic, no other gross or microscopical lesion being demonstrable. This is true also of human beings. Diphtheria toxins, pilocarpine, and the metallic poisons are further examples. Indeed, an important corollary from these observations must be that colonic irrigation with or without specific biologic media may be a laudable method of treatment for the above-mentioned conditions as well as of obstruction. Indeed, the authors are inclined to believe that the well-known efficacy of continued colon irrigation is effective in large part because of the mechanical washing away of the toxins with which the water comes into direct contact. In many cases of developmental reconstruction of the colon, their patients have absorbed as much as twenty-five litres of tap water during the first post-operative week. In addition,

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many litres flowed in and out, thus doubtless effecting direct elimination of toxins. This has been dwelt on by Combe. Analogies between the stomach and the colon are familiar, and one may be gleaned by studying the comparative effects of washing out the highly toxic duodenal and gastric contents, which usually accumulate in the stomach after operations on the alimentary canal, and the colon irrigations referred to. In interpreting the efficacy of stomach washing, as after morphine poisoning, we are, after all, only travelling where biology points when we assume that colonic irrigation has much the same value as gastric lavage. Further analogies between the stomach and the colon will be alluded to later on.

The eliminative diarrhoeas of constipation, of the syndrome called goitre, of nephritis, of syphilis, after the giving of salvarsan, further demonstrate that surgically the colon should be looked upon first as an excretory organ. But animal experiments show clearly that this applies only to the caudad colon. If this be true in the human, as seems reasonable from analogy and observation, then we certainly should hesitate to deprive any individual of so very important a function by the operation of total colectomy, and this irrespective of further metabolic considerations. Surgery, ceasing to be merely an adjunct to medicine, is rightly becoming the active collaborator of chemistry and physiology.

In studying the absorptive function of the colon, surgery has come further to the aid of physiology. Certain new facts of undoubted importance in human therapy have been learned by making use of surgical material, which recent operative procedures have afforded. Any digestive and absorptive function of the colon may naturally be taken on by its embryological prototype, the caudad ileum. Our surgical cases seem to prove this, and these human studies corroborate Cannon's animal findings as to the close physiological relationships between stomach and cæcum.

From a digestive stand-point the stomach and cæcum are unimportant. They are both receptacles, and if their motility is not impaired, they normally retain faint traces of digestive functions. The loss of these latter are not felt by any individual if the former is retained. Thus, every observer knows that the objective symptom called achylia gastrica may exist without any subjective symptom developing, provided that gastric motility remains normal. Von Noorden (*Path. of Metabolism*, p. 186) says, "Protein putrefaction in the stomach reaches a high degree only in the most exceptional cases, and only when both the *secretory and motor functions are completely out of order.*" Theoreti-



cally, as just stated, any digestive and absorptive function of the colon should naturally be taken on by its embryological prototype, the caudad ileum. Clinical experience and animal experimentation prove to the authors the stability of this hypothesis, based, as it is, on embryology. Their studies after ileostomy support it.

It is well at this point briefly to review the absorptive and related functions of the colon, as given by physiologists, and then to consider the further details of our researches.

In a recent paper Hertz says, "Antiperistalsis does not occur in man under normal conditions: the ileocecal sphincter does not always prevent regurgitation into the ileum. . . . There can be no doubt that the function of the sphincter is, as Keith originally suggested, to prevent the *contents of the ileum passing too rapidly into the cæcum.*"

This function is supplemented by the normal inhibition that is resident in the terminal ileum and can be accentuated under physiological requirements. The preservation, in part or in whole, of this inhibitory segment will, in the future, undoubtedly be an important factor in determining the point at which the ileum is to be cut, prior to ileocolostomy. This is supported by our clinical findings.

Drummond says, "After ileocolostomy the dilated coils of small gut adjacent to the colon *assume somewhat the functions of the large gut.*"

Von Noorden states, "Numerous experiments introducing protein bodies (myosinogen, egg albumen, and casein) into the rectum have shown conclusively that an absorption of natural protein *takes place in the rectum and colon.*"

Chittenden says, "In the large intestine . . . the last portions of available nutriment are absorbed."

Howell states that when the contents of the small intestine pass the valve they contain a certain amount of unabsorbed food material. "The food," he says, "in this portion of the canal is more or less liquid, and its presence sets up running waves of constriction which, beginning somewhere in the colon, pass toward the ileocæcal valve. These waves occur in groups, separated by periods of rest. The pressure of the ileocæcal valve prevents the material from being forced back into the small intestine. The value of this peculiar reversal of the normal movements of the bowel at this particular point would seem to lie in the fact that it delays the passage of the material toward the rectum, and, by thoroughly mixing it, gives increased opportunities for the completion of the process of digestion and absorption." This



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colonic digestion, it is conceded, must take place through the action of the enzymes, which are brought down from the small bowel and which, under favorable conditions, continue their activity in the colon. In this way it is estimated that at least from one to seven per cent. of the undigested foodstuffs, chiefly fats, are utilized. Now, if this is so, it means that a patient whose colon is static may lose this amount of food. Sir William Macewen was so impressed by this and by a case that came under his observation that he made the statement that, if the chyme was allowed to escape cephalad to the ileocaecal valve, the patient would lose weight, and that under those circumstances artificial feeding should supplement the ordinary diet. Our experience is at variance with this. Not alone is the loss of the normal absorptive function of the colon insignificant, but it is greatly overbalanced by the damage done to the organism through the toxic action of the end products of bacterial proteid dissociation which frequently occurs in the ill-developed, slowly emptying caecum and ascending colon. One characteristic result of this toxæmia is mental depression, which may even go so far as to result in mania.

CASE No. 1832 while at school attempted suicide three times; was treated by competent men from a neurological stand-point, and was finally operated on by Tuttle, with complete symptomatic relief.

CASE No. 2061 had been imbecile and bed-ridden for a year but recovered after ileostomy. Her debility was so great that the operation had to be done under local anæsthesia.

CASE No. 1180 (Path. No. 2081) presents the following data: Ileostomy, male, aged thirty, physician, weight 120 pounds, operated on April, 1912, for relief of acute inflammatory condition of colon with multiple polyposis. Owing to the existence of a common mesentery for ileum and caecum, both were brought outside the wound. Both were opened on the ninth day. Soon thereafter the following observations were made. The reaction of the ileac contents was always acid. The flow of contents was not constant, often being interrupted for several hours. Its consistency varied with the diet; excessive nitrogen caused fluidity; on mixed diet content was fairly well formed; sometimes very hard, when large, stick-like movements would be passed. No putrefactive germs, either anaërobic or aërobic, were found. No fecal odor was ever noted. Occasionally the odor was pungent and distinctly unusual. The only enzymes ever present were amyl-opsin, a marked, steapsin, a faint trace. Gain in weight over twenty pounds.

Another function that physiologists attribute to the cæcum and ascending colon is the absorption of water; all the water normally shall have been absorbed when the contents reach the mid-transverse colon. Surgeons have made ample use of these observations in support of various technical procedures, and a careful study of post-operative conditions shows, in some cases at least, that their premises or conclusions, or both, were incorrect. Our studies in the surgical physiology of the parts strongly suggest that embryology and physiology should always precede pathology as a basis for surgical therapy. Indeed, Bloodgood, doubtless the best qualified surgical pathologist living, states that the future hope of surgery lies in physiological chemistry.

Obviously, one cannot properly reason from a secondary basis alone, such as is offered by pathology, without having constantly in view also the elemental or primary sciences of embryology, physiology, and chemistry. Without, therefore, a knowledge of the intimate co-relationships that exist between all parts of the body in general and certain parts in particular, applied, or, as it is frequently and erroneously called, "practical" surgery cannot be further developed. Structures of common embryological origin, like the cæcum and caudad ileum, may show the greatest possible morphological variation, and yet lend themselves favorably to applied reconstructive surgery when this is done in harmony with both their origin and their function. Thus, the predominant conception to-day that the caudad colon, that is, the part aboral to the mid-transverse line, is capable of vicariously assuming the functions of the cæcum and ascending colon, as after ileocolostomy, may be correct, but is, in our opinion, incomplete. Surgeons have been led astray by the gross morphological differences between the caudad ileum and the cæcum, forgetful of the facultative co-partnership that must just as truly exist between these embryological units as between the morphologically identical portions of the colon. This, at least, seems to us a reasonable basis for explaining the observed interchange of function between the ileum and the colon, which we have herewith recorded. It may also serve to explain the present difficulty in forecasting the end-results after such operations as ileocolostomy. After the implantation of the ileum into different parts of the colon, a persistent diarrhœa or constipation has been known to occur. As a general rule, the diarrhœa ceases after a short time, but the constipation has proven to be a much more difficult problem to deal with. The explanation of these two facts is now apparent: the vicarious assumption of colonic function by the ileum is almost sure to come; it absorbs water and forms the fæces; but the constipation, a pathological condition which existed in the ileum

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previous to operation, obviously could not be influenced by the mere change of ileac position brought about by this type of operation. It might be influenced, perhaps, as shown in author's case No. 2012, by the exclusion of the inhibitory segment of the terminal ileum. Here the anastomosis, owing to adhesions, was made considerably oral to the termination of the foregut and, consequently, oral to the inhibitory segment. Indeed, this operation must increase the normal inhibition belonging to the part, thus aggravating the symptom. This increase of constipation has been noted in practice. This is quite distinct from the constipation due to anastalsis, and which frequently packs the cæcum after ileocolostomy, until its entire removal is necessitated. Lane states that this may be necessary, and Patterson places the instance at 5 per cent. or over. Probably it is much higher. Careful clinical study along these physiological lines is obviously indicated, so that surgeons may re-adjust their technical procedures upon a sounder basis. The ileac constipation is as yet open only to medical therapy and for this reason every effort at differential diagnosis between the two should be made.

Hertz presents some facts of interest here. He says, "An accumulation of chyme occurs in the last few inches of the ileum, where it remains and undergoes digestion, actually for a greater period than in the stomach. The normal ileac stasis is increased in all conditions leading to spasm or to the inhibition of the normal relaxation of the ileocæcal sphincter."

Conclusions based on the X-ray alone may lead one into grave error, owing, first, to the fact that röntgenologists are still unable to differentiate between stases due to mechanical and reflex causes, as, for example, between a mechanical kink and an ileac constipation, and, second, to the fact that it has not yet been definitely settled whether bismuth traverses the gut at the same rate as ordinary food, or slower.

What are our further proofs that cæcal digestion is negligible?

At a certain period of fetal life, as already said, there is little difference between the morphological appearance of the small and great gut. The latter, at first much smaller than the former, contains villi which are later obliterated, the process of obliteration not yet being definitely settled. It is assumed that Lieberkuhn's follicles are inverted villi. If so, they may, under the pressure of physiological requirement, revert to the fetal condition and vicariously functionate as villi in fat absorption. But fats must be emulsified before they are fit for absorption, and under the catabolic influence of lipase, which is present

in the colon as in all other tissues, emulsified fats may here be digested. In support of this, Tuttle claims to have increased the weight of a patient by the injection into the cæcum through a cæcostomy of emulsified fats. For the purpose of surgical physiology, however, it appears that the amount of fat absorption in the cæcum and ascending colon is of academic interest only.

Carbohydrate and proteid absorption in these parts occurred in Case 180, Path. N. 2081, as follows: Grammes, 30 dry peptonoids were mixed with grammes 113.4 warm water and introduced into the rectum at 11 P.M. At 8.30 the next A.M. the bowel was washed out from above with sterile water and the residue examined. Analysis of the peptonoids introduced was as follows (Lab. of Physiology, Cornell University): Protein 39.81, carbohydrates 50.05, water 4.72, ash 5.32.

Analysis of washings showed that one-half the sugar and nitrogen had disappeared. There was considerable fermentation which probably had a good deal to do with the disappearance of the sugar.

The nitrogen was in the form of amino-acids. This experiment suggests that proteins in the form of amino-acids may be absorbed from the colon. Normally, however, the amino-acids are absorbed in the small gut only. Under abnormal conditions of incomplete hydrolysis, peptones and other provisional products of protein digestion probably enter the cæcum, there to be converted by the proteolytic bacteria into the highly toxic by-products which, directly or indirectly, cause the familiar symptoms of stasis. Combe has called attention to the necessity of removing them by enemata. Adami regards the condition as a subinfection. Abderhalden has proved that the final product of physiological protein digestion is the amino-acids, having recovered them from the blood. It is clear, therefore, that for the purposes of modern surgery protein digestion in the colon is as unimportant as it is in the stomach.

Rectal alimentation has long been a comforting and satisfying therapeutic procedure in the hands of the profession. It was ancient medical history when Hippocrates was a boy. Recent physiological studies, however, show that the hypnotic influence of this old method of vicarious feeding has been at least as great upon the physician as upon the patient and his awe-struck family. Probably, the good which it is conceded may follow it has been due to the therapeutic action of the water and in no way to the food.

Our medical heritage is almost as rich in bewildering stimuli as our atavistic, which long antedates the batrachians. The one moulds our therapeutic ideas; the other fashions our form. We are encum-



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bered with a faith based upon a horde of inherited misconceptions, and the subject of rectal alimentation is only one of the many instances which prove it. Far be it from the province of surgery to set these right; surgeons are not Hamlets, but it is fair to say that the recent rapid progress of colonic therapy has contributed more than any other single factor of the day to endorse reconstructive ideas as well as applied procedures, and to show the pressing need of coöperation between the laboratories of the fundamental sciences and the hospital operating rooms. The unfriendly attitude existing in the past between physician and surgeon was a misunderstanding arising, as always, from ignorance and is rapidly being put aside. Medicine has evidently been at fault in treating, as in dyspepsia, the peripheral manifestations of some remote insult to the sympathetic system. Surgery, equally undeveloped, was at first simply the emergency tool of medicine, necessarily poor and crude. Gradually light has come from physiology, embryology and chemistry, until to-day surgery is able to offer, in selected cases, a therapy which, in removing the cause of disease, often effects a true cure. Such therapy is based on the incontrovertible premise that human beings are normally healthy animals and that for many chronic diseases there is a mechanical cause.

Intestinal stasis with its long train of protean and distressing symptoms is evidently a common ground upon which physician and surgeon may profitably meet to discuss, without bias or prejudice, the therapy of the future. Whether the developmental reconstruction of the colon herewith described will prove to be of lasting value may, perhaps, be doubted, but one argument favoring its continuance may well be its basis on embryological truths. It aims to correct a congenital deformity and is thus a form of orthopædic surgery. This speaks for its continuance, for the repair of congenital deformities must obviously continue long after the surgery of tumors and inflammations has happily passed away.

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## COLOCOLOSTOMY

A PRELIMINARY REPORT ON AN OPERATION FOR THE CONSERVATIVE RELIEF OF THE SYMPTOMS OF COLOPTOSIS AND COLOSTASIS

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WE are seeing an increasing number of patients suffering from a more or less general visceroptosis, on whom appendectomy, gastroenterostomy and gastropexy have been done and in whom the nutritional index continues far below par. The position and pathology of the colon in these patients have either been overlooked or only partially corrected.

This neglect has obviously not been intentional; it has been the outgrowth of the compelling notice which the pathology of the stomach and the duodenum has commanded. In some instances it has arisen from the disinclination to do too much visceral surgery at one sitting or to insist that the necessary work be done in two stages.

These patients are more frequently women than men, and are often classed as neurasthenics. The symptom complex is familiar to us all. They have pendulous abdomens, drooping shoulders, cold and clammy feet and hands, yellow complexions, coated tongues, and are constipated. The appetite is variable and capricious, there is marked indicanuria, they have frequent headaches, are mentally depressed and at times melancholic.

Many of them suffer from gas pains due to over-distention of the ascending and transverse colon. The descending colon is relatively collapsed and tonically constricted at its junction with the sigmoid, and, as has been repeatedly observed, this spasticity will persist even through a prolonged etherization.

A gastropexy with or without a plication of the gastrocolic ligament will not correct the essential defect in the position of the colon which produces these distressing symptoms. This defect is due to the very acute angulation at the splenic flexure, and not infrequently at the hepatic flexure, preventing the onward movement of gas and fæces and resulting in stasis of the colon contents.

The various methods of suspending a prolapsed and redundant colon have mostly proved inefficient, and absolutely so for the sharp splenic angulation.



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Cutting the colon out of the alimentary *via* by an ileosigmoidostomy or by a cæcosigmoidostomy has often been followed by failure to relieve the symptoms. Not infrequently the patient has been left in a plight more distressing than that for which he sought relief.

Total extirpation of the colon is a formidable procedure for the most experienced surgeon, and it must remain a serious question whether its justification can be consistently defended for that type of colonic stasis due to functional atony, ptosis and acute angulation.

With a view to suggest a conservative measure which should maintain the alimentary purpose of the colon and immediately relieve the

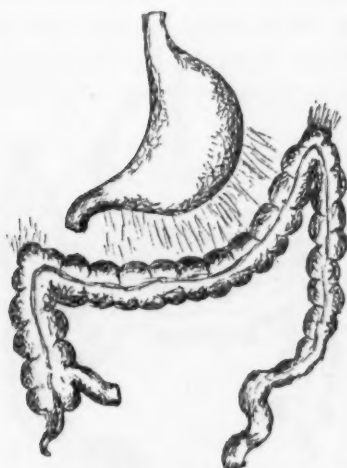


FIG. 1.—Showing the splenic and hepatic flexures in their approximately normal angulation.



FIG. 2.—Showing dilated ascending and transverse colon and sharp angulation at the splenic flexure. The descending colon is one-third the diameter of the transverse and is in spastic contraction at its junction with the sigmoid.

stasis and attending symptoms, at a meeting of the Los Angeles Clinical and Pathological Society two years ago I proposed the operation of colocolostomy.

At the last meeting, in May a year ago, a more detailed verbal report was presented with clinical observations upon five patients in whom the indications for the procedure seemed well established. Since that report four other patients have been operated upon.

It is obviously too soon to offer an opinion as to the permanency of the benefits to be derived from the anastomosis. But no unfavorable incident has thus far attended the operation and the patients have been so greatly improved as to lead me to venture to offer this preliminary

report with a brief technical description, in the hope that the procedure may prove one of value.

In all the cases the radiograms, which with one exception were taken with the patient in the standing position, showed the colon within the pelvis. In most of them the greater curvature of the stomach was several centimetres below the umbilicus. In one patient the stomach was down upon the pelvic brim.

The gastropnoxis was corrected, in those requiring it, as a preliminary step. The technic of Rovsing was the one usually chosen. Plication of the gastrocolic ligament was found necessary in most of the cases.

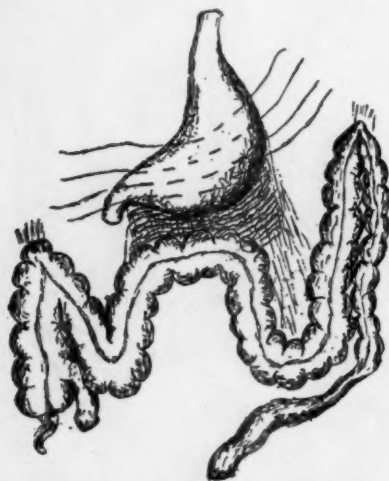


FIG. 3.—Suspension of the stomach and plication of the gastrocolic ligament only elevates the central segment of the transverse colon; the angle at the splenic flexure is not in the least changed or improved.



FIG. 4.—Suspension of the stomach, plication of the gastrocolic ligament and a colocolostomy between the ascending segment of the transverse and the descending colon, reestablishes the colon current and relieves stasis.

In those cases showing the hepatic flexure at an angle of approximately  $90^\circ$ , the anastomosis was done only on the splenic side, that is, between the ascending loop of the transverse and the descending colon.

Where, as is frequently seen in long and contracted waisted women, the angle of the hepatic flexure is  $5^\circ$  to  $15^\circ$ , the anastomosis will require to be done on the hepatic side also.

The site of the anastomosis is topographically opposite the umbilicus on the right and about two centimetres below the plane of the umbilicus on the left, through an incision through the rectus muscle.

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We found the transverse colon generally something more than three times the diameter of the descending colon. In three-fourths of the cases there was a marked narrowing of the descending colon for a distance of from three to five centimetres at its junction with the sigmoid.

The length of the anastomosis should be five centimetres.

The customary clamps and sutures used in gastro-enterostomy were employed.

The colon had been previously carefully flushed out with salt solution.

The strictest precautions in toilet required in the surgery of the colon were observed. In order to avoid the possibility of a loop of ileum slipping forward between the segments of the colon above the anastomosis, a line of sutures in the serosa should extend along the anterior bands from the upper angle of the anastomosis to the splenic flexure.

## ✓ DUODENOTOMY IN COMMON DUCT STONE

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FEW surgeons seem to realize that there is no typical operation of duodenotomy and that the word itself barely exists, although corresponding intervention into most of the cavities and organs is thoroughly recognized. The idea of a primary duodenotomy for duodenal ulcer is, of course, recognized for ulcers of a certain kind or site, for example, those on the posterior surface and hemorrhagic ulcers, but those may be left out of consideration here. According to those who have endeavored to trace the history of duodenotomy, the exploratory operation was first to be performed (Abbe, 1891), but, as will be seen, duodenotomy for stone began the same year. Some authors have sought to compile a list of duodenotomies for exploration, but few of these were single in character, for the exploration almost invariably led to the discovery of a calculus or cancerous growth. The duodenum has also been opened for exploration and operation on the pancreas. Since the overwhelming large numbers of duodenotomies have been for stone, the propriety of using so many compound expressions which signify the removal of stones through the duodenum is of highly questionable value; and has caused no end of confusion; nor does it seem much wiser to specify the precise site and direction of the incision as a sufficient reason for recognizing more than one kind of operation.

A word as to the existence of duodenotomy for stone before 1891. Langenbuch, as is well known, suggested the operation in 1884. Elsewhere he speaks as if he had actually done an operation like Kocher's, in the same year. He must, however, be referring to choledochotomy in the original sense, to wit, the establishment of a fistula between the choledochus and abdominal wall. A number of such operations were performed in the eighties, and there is no record that the duodenum was opened in this form of intervention.

Speaking of duodenotomies for stone, these have usually been grouped into three kinds; in the first, the operation cannot be called a choledochotomy. After the duodenal opening, the stone may be simply extracted or forced outward, or even crushed. The choledochus is not

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incised at any time. Why, then, call it a choledochotomy? It is a simple duodenotomy for extraction of stone which is almost loose, indeed, at times, actually loose. Next comes the numerically most prominent form in which the stone is impacted in the ampulla but readily freed by a small incision, too small as a rule to require suture. The third operation in which the stone is very large requires a sufficiently large incision for suture. To which is often added a plastic work, the formation of an anastomosis between the divided choledochus and the duodenum. It seems, however, that some surgeons prefer to employ this operation for routine purposes and, in general, the confusion between the three operations is great.

Thus in Kehr's latest work (*Der praxis der Gallenwege-Chirurgie*, 1913) the author states that in 2000 operations on the gall-bladder and biliary passages, he operated through the duodenum, 29 times. He does not state particulars, but we know that at first he employs choledochostomy, or the third type of duodenotomy for stone. Many other writers have used the terms indefinitely, saying one word when they mean another. Attempts have been made to compile two sets of statistics, one including the first and second type and the other the third, and keep them strictly separate. On account of the meagreness of many case reports, this is impossible, nor can we go by titles, for a choledochostomy as already cited may be a simple choledochotomy; the opposite error is less likely to occur. Some surgeons lay more stress on the site of incision, *i.e.*, the height at which it is made, than in the treatment of the duct which depends on a variety of conditions.

In the following pages we shall make no attempt to discriminate between the three types of operation. There is another matter of great importance in which it is not essential to make vital distinction. This is as follows: Patients who submit to these operations differ in no wise from other patients with severe biliary lithiasis. The personal course and symptoms vary little from case to case, whenever we have complete obstruction of the choledochus. The various clinical pictures should be familiar to all practitioners. Nothing appears to be saved by attempting to divide them into groups.

The material for duodenotomy for stone or conditions simulating stone is not large. It was recently estimated at about 100, but by including other material, like duodenotomy for the pancreas, certain choledochotomies formerly excluded, and late reports, as well as old unreported cases, the number ought to be well on toward 150. In this paper we cite 130 cases at least. However, we almost invariably find



that the most extensive operators seldom choose the duodenal route, and then often on an emergency indication. In Kehr's 2000 we find but 29. The Mayos report 6. Mayo-Robson 21 (up to 1908). Moynihan 10 (up to 1906). The reason for this small amount of material seems to be that these surgeons use the duodenal route only on the strictest indications. Preferring cystotomy or the retroduodenal method (the latter is sometimes carelessly spoken of as a duodenal method). Mayo-Robson's cases especially show that he used the duodenal method in highly complicated cases, and then only to meet some otherwise complicated conditions.

Of interest is the fact that several authors believed that they were the earliest to practise duodenotomy for stone. This is due to the insufficient attention given to the literature. McBurney chanced to record his first case in 1891, but it was not until 1894 that other reports came in, while it was not until 1898 that McBurney reported his total of six cases. He did not even publish five cases operated on after 1898.

In 1894 several reports came in, those of Pozzi,<sup>2</sup> Terrier,<sup>3</sup> Kocher,<sup>4</sup> Kehr,<sup>5</sup> At the same time, Kocher and Kehr independently introduced choledochostomy and Terrier's case falls under the same head. Pozzi's case fell under neither head and some would make of it a special operation, but his work was simply the result of conditions to be met; while endeavoring to reach the choledochus, he tore into the duodenum. It was found that a very large stone lay in the latter and common duct, having ulcerated through the latter. After having extracted the stone, the opening was carefully sutured. The patient's viscera were in bad condition, he having cirrhosis of the liver and extensive adhesions. Pozzi's operation was entirely unpremeditated. Therefore, in this group of 1894, not one was of the McBurney type.

In 1897 Czerny<sup>7</sup> and his assistant, Marwedel, operated twice on a gall-stone patient. The first, a cystotomy, found the choledochus apparently clear. Obstructive symptoms supervened eighteen months later, adhesions found between the gall-bladder and duodenum were accidentally ruptured into the latter, permitting removal of a stone low down in the choledochus. Hence this case is in the same class as Pozzi's first. Mayo-Robson's first operation, in 1897, we believed by Kocher's method.

In 1898 there was general activity in this field. McBurney reported his six cases. Langenbuch reported a case of duodenotomy for stone, with suture. Mayo-Robson reported his second case, having operated by McBurney's method. Collins,<sup>14</sup> of the U. S., reported five of McBurney's cases this year, but added nothing, and Carle,<sup>15</sup> several cases before the International Medical Congress at Rome, of the same operation. A case cited by Langenbuch, known as the Sarrenburg-Hermes case, is said to have been unfinished, or an operative failure. Riedel<sup>9</sup> reported a suture case. Haasler<sup>12</sup> reported a case of McBurney's, as did Sinclair White.<sup>13</sup> A case is attributed to Hoffman<sup>11</sup> during this period by



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Langenbuch. A statement attributed to Kocher that in 1899 20 operations had been performed with two deaths, falls short of the facts. The number should be much nearer 30 than 20. If, however, he refers to McBurney's operation, the number is approximately correct, as there were seven or eight cases of suture operations without counting others.

In 1899 and 1900 several more cases were reported. One by Pozzi<sup>2</sup> of McBurney's operation, a second by Lambotte,<sup>18</sup> a third by F. Page.<sup>17</sup> An era of importance is now introduced of the gall-bladder and bile duct (1900). The author seems to have been very little acquainted with the history of the operation, but announces that during 1898-1899 he had operated in all seven times by McBurney's method. As he had already published a case of Kocher's operation (1897), and his first McBurney case (1890), it appears that he added at least six new cases to the material. It is readily apparent that by 1900 no less than 35 duodenotomies had been performed for stone.

In 1901 Pataloni, of Marseilles, made the first serious attempt to write a monograph on "Biliary Intervention of the Duodenal Route" (*Rev. de gynecol.*, 1901, p. 72). He rendered good services in outlining the history and solution of the operation but did not succeed in collecting all the reported material.

In 1902 Robson<sup>20</sup> reported two cases of McBurney's operation (some writers credit him with three operations). Theinhaus<sup>21</sup> gives a personal case, and adds some five others from personal mention. W. J. Mayo<sup>22</sup> reports a case. Theinhaus did a suture operation. The total should now be over fifty.

In 1903 Gibson<sup>23</sup> reported a case of McBurney's operation. The next year was a prolific year for our subject. Mayo-Robson<sup>24</sup> published a second edition of his monograph. He adds seven new cases; also reports one by Dalzell for duodenotomy for pancreatic calculus. Ohl attempts to collect the total cases of duodenotomy for stone and knew so little of the literature that he could mention only a third of the published material. He gives four cases of Sprengel's, chiefly of the Kocher type. Then at the end of 1904, nearly seventy duodenotomies for stone had been performed.

In 1906 we see another prolific year. Hancock,<sup>25</sup> after reporting a case of McBurney's operation, stated that there were five cases of duodenotomy for pancreatic stone now on record (including Dalzell's, reported by Robson). Moynihan<sup>26</sup> published a comprehensive paper in which he speaks of seven cases of McBurney's operation and three of the suture or Kocher operation. Lagurette<sup>27</sup> reports a single case of McBurney's type. The total at the end of 1906 amounted to about 80 cases. Kocher<sup>4</sup> writes up 100 cases of operations on bile passages; aside from the original case, he has operated twice more; but a single paper appeared in 1907 by Webster,<sup>28</sup> of Chicago, who reports a case. To the series of 1906 must also be added the five unpublished cases of Mayo and the five unpublished McBurney cases. These McBurney cases bring the total up to over 90.

In 1908 there was renewed activity. Connell<sup>29</sup> reported a personal case and cited unpublished cases from Sifton,<sup>31</sup> Tinker and Sherck. Mayo-Robson announces to correspondents that he had done 6 more operations since 1904; this gives an additional 12 cases which makes a total of over 100.

In 1909 MacLean,<sup>32</sup> of Winnipeg, reported a case, and in 1910 another report

appeared from Smythe,<sup>28</sup> of Memphis. In 1911 Bosse and Brotzen<sup>24</sup> reported a single case.

During 1912-1913 not a few cases have seen the light—Fobes,<sup>25</sup> W. Meyer,<sup>26</sup> Williams<sup>27</sup> (Louisiana), Brewer,<sup>28</sup> Hubbard<sup>29</sup>; this equals 6 cases. Kehr's latest work, already mentioned, gives his complete figures as 29, of which 4 only seem to have been reported. Deducting this number, we have 31 cases to add to the number of cases. An unlocated case of Hoffman would make the grand total nearly 140. To do anything in the way of tabulation and analysis of these cases is straightway impracticable. Some are given in full detail, but many are defectively reported, and not a few mere hearsay cases. To select arbitrarily, certain cases for analysis of 94 cases collected by Connell<sup>31</sup> as sample for the purpose, but it teaches us little. Of much more value should be the different conditions under which the operation has been done.

In Hubbard's analysis of 94 cases he could only credit Kehr with 3 cases of McBurney's operation, while 8 of Kehr's own operations are not included. He admits that some surgeons look upon the two procedures as identical. His series of 94 he evidently regarded as all non-suture operations, but if he had read them all he would have found that not a few supposed McBurney cases were really suture cases. In the 94 cases Hubbard could find records of but 12 fatalities. Duodenal fistula was a theoretical objection, but two cases only seemed to have been recorded. With modern technic fatalities and untoward sequelæ seem hardly possible.

In regard to the operation itself, it must first be borne in mind that few of these are undertaken with the sole aim of removing a stone which blocks the common duct. It is only as a sequela to a gall-stone operation, when the symptoms do not improve, or when the attacks by obstruction continue to occur, that we see operations directed solely to the ampulla, for the gall-bladder and cystic duct may have been sacrificed. In the majority of cases, operation for gall-stones must include a thorough exposure of the other structures just mentioned. These may be normal, or may demand immediate relief.

In approaching the case histories we may cite a few of the latest accessors, which will throw some light on the causes for intervention, the selection of cases. None of the cases were desperate and none of the reporters had operated before. One operator had never as much as heard of duodenotomy, but improvised it. Thus J. C. Hubbard,<sup>29</sup> of Boston, reports a very recent case. A woman of thirty-eight was seized with the symptoms of biliary obstruction. An incision exposed the biliary organs, but no stone was found, save a small one at the duodenal end of the common duct. Since it could not be pushed out the duodenum was opened in front and the posterior surface incised over the stone. Afterward the incision in the anterior wall was sutured, and the gall-bladder drained with a wick.

Hancock's<sup>30</sup> case was also simple. The patient had already had the gall-bladder drained along with 70 stones. However, the symptoms of obstruction returned, and an impacted stone, overlooked, was found in the common duct,

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where it passes through the duodenal wall. The stone was firmly impacted. The anterior wall of the duodenum was incised, the papilla dilated and the stone removed. Later, the gall-bladder was removed.

In the case of Bosse and Brotzen,<sup>24</sup> the condition was evidently of long standing, and was thought to be confined to the bladder, which was bound with adhesions. The choledochus was pronounced patent. Gall-bladder removed. Later, further obstruction. Second laparotomy; found much scar tissue, choledochus could not be recognized in the mass. A small stone felt in the duct. Retroduodenal method found impracticable. Duodenum mobilized and incised in front. The stone was extracted. There was no drainage, but a tampon was used for a short time.

In the two preceding cases the choledochus was accused only after the belief that the trouble was in the gall-bladder.

In Smythe's<sup>25</sup> case the diagnosis had been gall-stones and stones in the common duct. In the operation an attempt was made to remove all stones through the cholecystotomy wound. Author had never heard of duodenotomy, but it seemed indicated. He found the duct thin and containing one large and several small stones. No attempts were made to suture.

The above four cases were all of recent date of a common type, yet presenting dissimilarities.

If we glance over these reports we note that the surgeons had never operated before and that this method appealed to them because it suited the indications, was not difficult of execution, was practically without mortality, and serious complications were absent. From the time of McBurney's, many of these cases had been performed. It is, however, almost certain that the heavy operators would have used a different technic, *i.e.*, the general technic for all gall-stone operations, or the retroduodenal method. The single case operators mentioned above are not known to have used this resource again, probably from lack of opportunity. As a matter of fact, most cases have been reported singly.

There is a much more difficult type of case in which the operation has been done to save life. Here attacks of biliary obstruction have occurred during many years, operative intervention may already have been practised once or twice, the patient has become cachectic and severe complications may have to be dealt with. The biliary passage may have become the seat of inflammation (cholangitis), so that fever may be associated with the picture of obstruction.

Of this type was Kehr's first case. There had been biliary crisis for five years, which at last appeared almost weekly. The general state was most wretched. The icterus was intense and hypertrophy of the liver existed as complication. The gall-bladder was small and empty, adherent to duodenum and stomach. A large immovable stone could be felt in the duodenum. It lay directly opposite the anterior portion of the latter. Kehr, already a seasoned operator for gall-stones, saw no other way of reaching the stone but

by a transverse incision and then making a second incision directly upon the choledochus. The stone was removed, and the split duct sutured to the mucosa above it. Hence, for Kehr, this was really an emergency procedure. If we study the cases of the large operators we get the same impression. A majority of Mayo-Robson's cases were of this sort, many of them desperate. In the midst of a severe operation for small stones, he finds it necessary to do a choledochotomy before the work can be completed. He thus lost two of his early cases, one from infection and the other from acute gastric dilation. To take some of his subsequent cases without mortality,—in his case 354 the patient also had chronic pancreatitis and was suffering from an independent wound in the leg. The stone was large. The operation was successful (no suture of duct) and recovery rapid.

In another case, 436, the woman had had a long history of gall-stones, and had gone through a cholecystotomy, as a result of which she now has a biliary fistula. A duodenotomy was performed and the stone removed. As the duct seemed contracted, it was well stretched with forceps and the papilla laid open, all to prevent recurrence. There is evidence that recurrence will occur.

Case 480 was of special interest, because during manipulation after a cholecystectomy one stone was forced into the ampulla. As it could not be dislodged, the author was forced to perform a duodenotomy.

Case 487. There were both cholelithiasis and pancreatic calculi. There were performed cholecystotomy, duodenotomy and pancreatotomy.

Moynihan,<sup>22</sup> a frequent operator, reports some severe cases. In one woman he removed 87 stones from the gall-bladder, hepatic and common duct. He cut down the length of the common duct, but at the very duodenal end of the latter found a tightly impacted stone, for which he performed a duodenotomy. The choledochus was sutured from the gall-bladder downward. This patient died on the third day from hæmatemesis.

In another of his cases of a severe type, with gall-bladder useless, the latter was extirpated along with the cystic duct. Stone in ampulla removed by duodenotomy. Recovery ensued. In a third patient cholecystotomy was done after duodenotomy for drainage purposes. In a fourth, the gall-bladder was first removed, and later a duodenotomy for stone in the common duct performed. The gall-bladder stump permitted drainage by the cystic duct. It is taken for granted that gall-bladder or cystic drainage implies actual or possible infection.

Sprengel<sup>23</sup> had operated four times at an early date and his cases seem to have been unusually severe. The patient had already been operated upon twice (choledocystotomy). A third severe attack occurred and was found due to a stone in the ampulla. Duodenotomy and removal of stone. Gall-bladder drainage. Recovery. In another, case history of severe biliary obstruction. Operation located stone in ampulla. Choledochus opened above and attempts made to extract or push out the stone. This failing, duodenotomy was performed. Tampon near duodenum with hepatic drainage. Wound healing kindly when duodenal suture gave way. Tampon soaked with bile and blood. Emergency gastro-enterostomy; death. Autopsy wound in duodenum had undergone digestion. In a third case, the gall-bladder was full of stones, choledochus much dilated, with one stone in ampulla. High incision of choledochus



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practised, but stone could not be dislodged. Duodenotomy and extraction. Hepaticus drainage recovery. In a fourth case, the gall-bladder was found adherent to stomach and transverse colon. Stones, few in number, removed through gall-bladder and duodenum. Recovery.

Kocher,<sup>4</sup> who is reckoned as a prolific operator on gall-stones, had done up to 1906 but three duodenotomies. His earliest one was done by the so-called Kocher operation, which he originated almost simultaneously with Kehr (suture of incised common duct to edges of divided posterior duodenal wall). In his second case he found the duodenum fused with the gall-bladder. He partially loosened the adhesions. A stone lay in the choledochus, which at this point was surrounded by adhesions which could not be loosened. It could only be reached through the duodenum. The latter was opened and the pylorus temporarily closed. The stone was cut out and suture of the choledochus to the duodenum. Entire wound tamponed with external drainage. Convalesced slowly. A third case had tumor symptoms. Gall-bladder shrunken and adherent, no tumor. A body, thought to be stone, in choledochus. Duodenotomy with probing of common duct. Four centimetres from duodenum a stone found, character doubtful. Severe hemorrhage from tear in old adhesion led to clamping for two days. Wound meanwhile being tamponed and drained. Obstruction removed but no mention of nature. Death due to the adhesion afterward torn.

H. B. Robinson<sup>25</sup> is said to have reported in all three cases. We have found two only. In the first, the author found the gall-bladder the seat of adhesions. In attempting to remove some of them, the gall-bladder ruptured, and was found to contain no stone. A temporary fistula was left and finally closed. There was another obstructive attack with reopening of the fistula. A second operation was performed. Diagnosis meanwhile of movable stone in the choledochus (intermittent jaundice). Numerous dense adhesions had to be disposed of before the latter could be reached. No stone could be found, and the wound was allowed to heal. The obstructive symptoms reappeared and a third operation performed. Gall-bladder and duct in good condition, no stones, but a slight thickening at the lower end of the choledochus. The duodenum was now opened, and incision of the duct showed a concretion the size of a marble.

The other case was evidently infected cholelithiasis. Laparotomy—all the biliary organs in position to be examined. Gall-bladder empty. Two stones in choledochus removed through duodenum. Recovery.

Brewer<sup>26</sup> has operated at least twice with fatal results. In Brewer's first case he blames only himself. Patient, an old man, with gall-stone disease and fever, underwent laparotomy. Common duct much dilated, containing what seemed to be an enormous stone. The gall-bladder itself infected and was extirpated, the duodenal end of the choledochus clamped and the contents of all the ducts removed. The duodenum was now entered, the common duct enlarged and the mass removed. It was not a stone but inspirated bile and pus, the result of an old fistula between the gall-bladder and duodenum. The supposed common duct had really become effaced. The new passage had become infected. The operation was a very long one and was successful, but death took place the sixth day, from hypostatic pneumonia.

Brewer cites briefly a second case in an old woman. He first did a duodenotomy, dilated the lumen of the duct with Kocher's forceps, but found no



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stone. He then made an anastomosis between the gall-bladder and duodenum. Death resulted.

A fatal case mentioned by Lilienthal in 1903 may perhaps have been a direct duodenal fistula. It occurred in the practice of a colleague and is termed a duodenotomy. The author mentioned it in discussing a paper by Gibson, on what was evidently a McBurney or Kocher operation. The death took place from a leak in the duodenal wall, with resulting peritonitis. This accident is not feared in duodenal operations.

Pozzi,<sup>2</sup> in addition to his accidental duodenotomy, performed a second operation of the familiar type.

Clarke,<sup>3</sup> a French surgeon, simply announced that he had operated by duodenotomy several times with success. He thought the operation original with him, or at least states that he knew nothing of the cases of Kocher and Pozzi. However, he mentions Terrier, as if he had employed the latter's technic. It is hearsay that Ferguson and Oschner, of Chicago, have each operated twice. The four cases are not on record. Sifton is also said to have operated three times, with one fatality.

We have purposely left McBurney<sup>1</sup> and Collins<sup>4</sup> as among the last to be mentioned among plural operators, despite the fact that McBurney was a pioneer. He had operated six times up to 1898, in which year he published a very incomplete report of his cases. Collins, his assistant, is also credited with five cases supposedly his own. If, however, we compare the two reports, we see that aside from McBurney's first case in 1891, the two sets of cases, of five each, are identical. To clinch the matter, the title of Collin's paper states plainly that McBurney was the operator.

McBurney's pioneer case, not included in Collin's series, was accidental as far as gall-bladder surgery goes. The diagnosis was carcinoma of the liver with cachexia. Only the fact that the patient became no worse led finally to a laparotomy. No cancer was found. As patient gave a history of biliary crisis, McBurney broke away some adhesions from the atrophic and empty gall-bladder and was able to palpate all the ducts. A hard mass was palpated behind the descending portion of the duodenum. As the choledochus could not be exposed, the only course to pursue was to open the duodenum (Dr. Briddon, in discussing this subject, said that before McBurney's operation it was the custom to leave these cases alone, as inoperable), which was done with a vertical incision of one and one-half inches. Choledochus dilated and stone was extracted with forceps. The duodenum was sutured but external drainage practised for two days. Recovery. McBurney did not operate again until December, 1896. This case ended fatally in three days. McBurney ascribes death to sensitive stomach and uncontrollable vomiting. Collins mentions intense meteorism. No infection, no peritonitis, etc. The same technic used as in the case 1891. The third operation was performed in June, 1897, and was one of multiple gall-stones, gall-bladder cystic and common duct. Of interest because of partial recurrence, due to fragment of stone left behind. There were two more cases for which Collins can find no documentary evidence, but he recalls their recovery. The sixth case was reported in full by McBurney and somewhat resembles his first case. There were likewise enlarged liver and suspicion of cancer. The gall-bladder was atrophic and adherent to the duodenum. The forceps were used

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to dilate the ducts. McBurney operated with or without incision of the duct in his cases. In addition to these six cases, McBurney continued to operate for four or five years and brought his total up to eleven. He had no further mortality. The last five cases he never reported or caused to be reported. For a man who devised so important an operation as duodenotomy for stone, he seemed to have taken but little interest in it. His obituaries do not allude to it. His cases do not appear to have been of the desperate type often encountered.

Equally unsatisfactory is the state of the Mayos' material. In 2000 cases of biliary surgery, they are said to have done duodenotomy for stone just six times (see Hancock). One reported case seems of the simple type, and about the rest little is known, save that there was no mortality. On one occasion they did a duodenotomy for what was found to be cancer of the ampulla, the latter having been the probable diagnosis.

Of the various isolated cases reported many offer nothing worth recording, or which has not already been quoted, or which has not been amply covered in cases already quoted. Others deserve mention for some unusual complication. Certain authors lay great stress on extensive mobilization of the duodenum, drawing it onward and holding it in place with traction of sutures. Others, whatever they may do, fail to mention such extreme thoroughness. This manoeuvre is necessary in the retroduodenal operation. One of the chief reasons for duodenotomy appears to be the inability to satisfactorily mobilize the gut by reason of adhesions.

Dr. E. M. Miller,<sup>17</sup> who practises in Patterson City, in Louisiana, operated on a very complicated case successfully and left behind the diseased and densely adherent gall-bladder between which and the duodenum there was fistulous communication. The gall-bladder and small duct chanced to be free from stones, but these could be palpated in the common duct. A duodenotomy showed a small fistulous communication with the gall-bladder, and the stone was removed from the duct. The fistulous tract was let alone, and the duodenal wound closed.

Haasler's<sup>18</sup> case, simple in type, presents some interest because the stone when palpated simulated a duodenal polyp.

In Theinhaus's<sup>21</sup> case the gall-bladder and cystic duct were as if made of stone so great was the degree of infection. A number of stones were strung along the common duct. The author tried to attack the latter from above, splitting the duct as far down as possible, but in vain. The duodenum was sutured by the usual incision and a second one because necessary. The duct was split below and a large concretion dug from the ampulla. The posterior duodenal wall was then sutured to the split duct.

Lagurette<sup>22</sup> in a complicated case of gall-stones first evacuated the gall-bladder, and then attempted the retroduodenal operation for stone in the common duct. He mobilized the gut but could not reach the stone. He next did a duodenotomy, removed the stones, and finally extirpated the gall-bladder and cystic duct. This seems to have been a purely emergency extemporaneous procedure, as Lagurette does not mention the names of other operators.

J. C. Webster,<sup>20</sup> evidently a heavy operator, never saw but one case in which duodenotomy was the indication of necessity. The ducts were enormously distended, and a diverticulum had formed in the common duct which contained stones.

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Connell,<sup>21</sup> like Webster, resorted to duodenotomies after the retroduodenal operation had failed.

Hancock<sup>22</sup> and others cited from literature five cases of duodenotomy for pancreatic stone, quoting Dalzell, Mayo-Robson, and Clarke. Three are known to have not differed essentially from duodenotomy for choledochus stone. The others presented some deviations in technic, but all may be enumerated as duodenotomies.

PERSONAL CASE REPORTS.

CASE I.—An electrician, fifty years old, entered the hospital, March 29, 1907. Family history was negative. Had been well until fifteen years ago, when he suffered a severe attack of pain in his epigastrium, followed by jaundice and a sore feeling in the stomach which lasted some days. At first these attacks came frequently, but lately the intervals have been longer. Some of the attacks have been followed by vomiting, lasting from three to five days. A high temperature with severe chills. Pain would waken him in the middle of the night, with vomiting, with relief. Since October, 1906, the symptoms have been much worse and he has been compelled to give up work since the first of the present year. Jaundice with a slight temperature at times, with bile in the urine, has been almost constant for the past three months. No symptoms of stasis, no hæmatemesis. The weight has remained about the same for the past fifteen years.

*Physical Examination.*—Left pupil slightly larger than right, both slightly irregular, but react. Abdomen tympanitic, rigid, with tenderness on deep pressure in the epigastrium. Greatest to the right of median line along costal border. Examination otherwise negative, except the marked continuous jaundice. Stomach examination: Capacity 2500 c.c. No masses were felt over the stomach. Normal in position. Fasting contents 10 c.c. of clear fluid. Guaiac negative. Free hydrochloric acid. Total acidity high. Diagnosis: Gall-stones probably in the common duct with inflammatory adhesions about the pylorus and first portion of the duodenum.

*Operation.*—Ether anæsthesia, preceded by morphine and atropine. Incision through right rectus muscle, near median line with centre about one inch above the umbilicus. Appendix normal. Dense adhesions about the under surface of the liver and gall-bladder tract, stomach and duodenum. Gall-stones were distinctly palpable, deep in the common duct. An effort was made to separate the adhesions from the under surface of the liver and approach the ducts through the superduodenal space. Owing to the profuse hemorrhage and slow progress, efforts in this line of attack were discontinued. The duodenum, with common duct and

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stones beneath, was picked up and an incision, about an inch and one-half in length, made in the intestine, the stones palpated and pushed toward the ampulla of Vater, from which they were easily extracted. The incision in the duodenum was closed with an interlocking through-and-through continuous chromic gut suture. Over this a running suture of silk, catching only the serosa. A drainage of gauze rolled in rubber sheeting, being placed in position, the abdomen closed.

The patient made a fair recovery, jaundice rapidly disappeared, also bile from the urine lessened greatly in amount. The drainage was removed on the third day. On the eleventh day when the wound was practically closed, the patient suddenly was seized with severe pain in the epigastrium, which was followed by a profuse discharge of fluid contents of the stomach and duodenum, upon the abdominal wall. This distressing condition lasting for three weeks, when the amount gradually began to lessen and finally closed at the end of seven weeks, the patient being fully returned to health in a short time afterwards.

CASE II.—A farmer, aged fifty-eight years. Family history negative. Has always been well except for the past year, has experienced a dull pain in his abdomen, at the costal margin. No radiation of pain. No acute pain anywhere. No vomiting. For the past three months there has been marked jaundice, showing in the conjunctive skin and urine. Complains considerably of heart-burn and acid stomach. Has no hunger pains. The pain being somewhat more intense after a full meal. The stools are very light in color and putty-like. No hæmatemesis or blood by rectum.

The patient is well developed and in a fair condition of nutrition. While lying flat in bed, has no apparent pain, but on slight movement of the body and exercise or work, the pain is noticeable. The abdomen is symmetrical, level, tympanitic and soft. On the left side of the epigastrium there is slight muscular spasm. Tenderness on deep pressure at the mid-point between the centre of the ninth rib and the umbilicus. Liver dullness, fifth rib in the mammillary line. Edge of the liver about two centimetres below costal border. Stomach analysis negative. Blood examination normal. Urine negative, except the presence of bile. During the past week, the patient has had a temperature ranging from 99° to 102°, with several slight chills. Diagnosis: Biliary calculi probably in the common duct.

*Operation.*—Right rectus incision. Few adhesions. Gall-bladder thin, bluish in color. Markedly distended. Contents of gall-bladder aspirated and opened. No stones found in gall-



bladder. Upon palpating the ducts, four stones about one and one-half centimetres in diameter were located. On account of the success of Case I, and it seemed apparently the easiest method of approach, the transduodenal route was again selected. A small incision was made through the duodenum and the stones forcibly expressed through the ampulla. Little difficulty was experienced in so doing. The incision in the intestine was closed with two layers of fine linen. Tubular drainage placed in the gall-bladder and a small cigarette drain placed along-side of its lower end, attached by a catgut suture to the duodenum, over the incision. Cigarette drain removed at the end of 48 hours. Gall-bladder drain in 8 days.

Recovery uneventful, no leakage from the duodenum. Patient was kept on liquids, other than milk, for the first week. Wound closed in 30 days.

CASE III.—A house-wife, aged thirty-two years, entered the hospital October 10, 1908. Family history negative. Had suffered from the usual diseases of childhood. No serious illness other than a comparatively mild attack of typhoid fever in 1903. For the past few years the patient suffered from severe attacks of pain in the upper abdomen, radiating to the right shoulder, accompanied by vomiting and followed by jaundice, chill and fever. The attacks were of such severity and frequency that the patient had been permitted by her physician to carry a hypodermic syringe and administer morphine herself.

*Physical Examination.*—A very obese, short woman. Excruciating pain upon pressure in the right upper abdomen. Refused test-meal and stomach tube. Urine contained much bile. She urged operation at once, as the diagnosis of gall-stones had been repeatedly made by many physicians.

*Operation.*—A long right rectus incision, necessary on account of the large amount of fat. Stomach and liver adherent. Gall-bladder not located. Stones palpated deep in the common duct. Duodenal incision, extraction of three stones about one centimetre in diameter. Incision in duodenum closed by two layers of fine linen and drainage with iodoform gauze, rolled in rubber sheeting.

Recovery in four weeks, uneventful and no leakage from the duodenum. She has remained in splendid health ever since and with the relief from the distressing condition, the morphine was soon no longer necessary.

CASE IV.—A house-wife, aged thirty-two years, entered the hospital, April 15, 1910. For the past five years she has suffered from attacks of pain, commencing in the epigastrium and radiating to her shoulder blade. Each attack has lasted several hours and



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been accompanied by rigor and vomiting, followed by jaundice. During the past year the attacks have been more severe and frequent, the jaundice remaining during this entire period. There was tenderness on deep pressure below the right costal border. No distention of the gall-bladder could be felt. Diagnosis: Stones in the common duct.

*Operation* (two days later).—Right rectus incision, extensive adhesions between gall-bladder, stomach, duodenum and omentum. Gall-bladder contracted and not located. Incision through the duodenum, ampulla located and dilated. Many small stones removed from duct with a scoop. This was followed by a quantity of bile and mucous fluid. Incision in duodenum closed, double row of linen sutures, gauze drain. Disappearance of jaundice in a short time.

Report more than a year later shows her perfectly well.

CASE V.—A plumber, aged forty-two, in good general health, entered the hospital, December 1, 1911. For the past four years has suffered frequently from attacks of pain over the gall-bladder. Vomiting frequently with attacks which were followed by slight jaundice. No rigor. No chill. Had been seen by a number of physicians at various times and all diagnosed gall-stones.

*Operation*.—Adhesions of the liver, gall-bladder, duodenum and stomach. Gall-bladder distended, aspirated, stones located in the common duct, incision in the duodenum. Four stones extracted with scoop and forceps from the common duct. Rubber drain in the gall-bladder, gauze rolled in rubber sheeting placed along the duodenum.

Recovery delayed by severe ether bronchitis but eventually recovered and has remained well.

CASE VI.—A business man, aged thirty-eight, entered the hospital March 5, 1911. First attack of pain five years ago, followed by attacks every month. Since 1910 the attacks have been very frequent, occurring as often as every few days. Pain very severe, radiating to the shoulder and subscapular region. Pain accompanied by vomiting and always followed by jaundice, chill and fever. A large, tender mass detected below the right costal margin.

*Operation*.—Right rectus incision through the fibres of the muscle. Adhesions, gall-bladder very much thickened and inflamed. One hundred and twenty-five stones removed from the gall-bladder and cystic duct. Common duct blocked by several stones. The bad condition of the patient, the extensive adhesions, suggested duodenotomy. Duodenum incised, stones removed, gut sutured to duct, gut closed, tubular drain in the gall-bladder, gauze drainage to site of incision in the intestine.

Recovery good. No leakage; well at the time this report was written.

CASE VII.—A farmer's wife, aged fifty-eight, entered the hospital early in 1912. Diagnosis: Gall-stones in the common duct had been previously made by her physician. The history she gave showed frequent attacks of pain in her upper right abdomen. Tenderness at the costal margin. The attacks of pain were accompanied by chills and fever, and followed by jaundice.

*Operation.*—Right rectus incision, dense adhesions, gall-bladder contracted, palpable, with the fundus tilted downward into her loin. Large stones palpated in the common duct, near its opening into the intestine. Duodenum and the common duct, with stone included, surrounded by dense adhesions, picked up between the fore-finger and thumb of the left hand. Incision in duodenum, extraction of the very hard stone, about three centimetres long by two centimetres in diameter, through the ampulla of Vater, closure of the intestine, no drainage and rapid recovery.

CASE VIII.—A very obese woman, aged twenty-four, wife of a station agent, was first seen at the Adrian City Hospital, June 4, 1912. History: Frequent attacks of pain at the right costal border. Tenderness on pressure. Pain radiating to the mid-scapular region. Vomiting, chills, fever, and jaundice. Right rectus incision, very dense adhesions, stomach, liver, duodenum and omentum. Gall-bladder probably obliterated, not located. A small stone palpated through the duodenum, near the opening of the common duct, into the intestine.

The dense adhesions, the fat wall, extreme difficulty with which separation of the adhesions was effected, the transduodenal method was again selected. One-half inch incision was made and a small stone was extracted from the ampulla. Incision closed, large pack of iodoform gauze was placed around the duodenum, as there had been considerable escape of fluid from the intestine and some hemorrhage from the separating adhesions.

Recovery four weeks later. Jaundice disappeared, patient remaining well afterwards.

CASE IX.—An iron worker, aged twenty-one, brought to the hospital, September 19, 1912, in an ambulance. When seen, his condition was one of great shock, pulse almost imperceptible, temperature subnormal, surface of the body cold, face pinched, pale and covered with profuse perspiration. Lips and fingers blue and respiration shallow and rapid. Suffering from intense abdominal pain. Morphine and saline solution were administered. Examination of his abdomen revealed a large mass on the right side with

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its mid-point on a line with the umbilicus. This mass was about 20 cm. long by 15 cm. wide. Was well definable by the naked eye, as well as by palpation. The abdominal wall was hard and retracted. The patient had vomited profusely just prior to this attack.

From his brothers we learned that this young man had suffered from the usual diseases of childhood, had been well and a hard worker up until about one and one-half years before this illness, he had suffered from typhoid fever, after which he regained his usual health. Ten months before present illness, he had attacks of pain in his right upper abdomen, vomited, followed by fever, chill and jaundice. These attacks were frequent and often prevented him from attending to his duties for a period of a week at a time. He had vomited blood two or three times. There was no knowledge of the character of his stools. The attacks had been daily for the past week before entering the hospital. No history of hunger pains. Provisional diagnosis made of a slow perforating duodenal ulcer with abscess or possible gallstones. The patient was in a very low state of general nutrition.

Operation two hours after entrance to the hospital. Right rectus incision. No fluid in abdominal cavity. Stomach and gall-bladder, liver and omentum adherent. Mass directly under the lower portion of the duodenum. Palpation of the mass did not reveal positively the presence of stones. Bad condition of the patient, probably stones, lead me to believe that the transduodenal method offered the only solution possible. Duodenum incised, ampulla located, pressure made on the mass, which forced from the duct, semisolid biliary material. Ampulla incised and dilated, a pint or more of partially solid stones removed. Incision closed with catgut and linen gauze drainage.

Convalescence rapid, patient gained daily, drainage removed on the fourth day. On the eleventh day the patient experienced a severe pain in his abdomen, grew cold and clammy. Stimulants administered, dressings changed, contents of the stomach and intestine upon abdominal wall. This continued for ten days more, ending in death from starvation, no food having entered the lower intestine. Gastrojejunostomy with pyloric closure would probably have saved this patient.

No one familiar with the facts will deny the difficulties encountered in dislodging a stone impacted in the diverticulum of Vater or the extraction of a stone from the superduodenal portion of the common duct, by choledochotomy. That duodenotomy is safe and rational and should be more frequently practised than appears from a study of the literature of this subject, that the operation of duodenotomy is much easier

and safer than choledochotomy where stones are located low in the ductus communis or impacted in the ampulla of Vater, I think is clear. Basing these conclusions upon a study of nine cases with only one death, these results compared with the mortality which occurred in 30 other cases of common duct stones in my work, compels me to be greatly in favor of the method of duodenotomy when indicated.

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# THE MORTALITY STATISTICS OF TWO HUNDRED AND SEVENTY-SIX CASES OF ACUTE INTESTINAL OBSTRUCTION \*

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AND

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THIS study of the mortality statistics of intestinal obstruction is based upon a series of 276 consecutive cases of acute intestinal obstruction admitted to the German Hospital in the ten years ending with 1913. Some of the earlier histories were far from complete, and we have therefore used only those facts which could be found in practically all of the histories.

The etiology of the cases was as follows:

Post-operative adhesions .....	81 cases
Post-inflammatory adhesions .....	16 cases
Strangulated hernia .....	156 cases
Inguinal .....	77
Femoral .....	50
Umbilical .....	21
Ventral .....	7
Subdiaphragmatic .....	1
Carcinoma of sigmoid .....	8 cases
Volvulus .....	5 cases
Fecal impaction .....	3 cases
Intussusception .....	2 cases
Adynamic ileus .....	2 cases
Congenital bands .....	1 case
Cause unknown or not recorded .....	2 cases

Of the 276 cases, 158 recovered and 118 died—a mortality of 42 per cent. One case is reported as improved, possibly one of the rare instances of spontaneous recovery or a mistaken diagnosis. The case noted as unimproved on the records probably declined operation and insisted upon discharge from the hospital.

A mortality of 42 per cent. in a large series of cases of acute intestinal obstruction is not an unusually high one. It is far higher than it should be, but an analysis of the records will easily disclose very definite reasons for such an unsatisfactory state of affairs.

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\* Read before the Philadelphia Academy of Surgery, October 5, 1914.

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In 241 cases we found adequate records of the average time from the onset of the condition to the time of operation. In the cases that recovered it was 61.7 hours or over 2½ days, and in the case that died, 97 hours or 4 days and 1 hour. Under such conditions it is to be wondered at that so many cases had a fortunate outcome.

There is no doubt that in practically every instance, taking similar classes of cases, the time elapsing between the onset of the obstruction and the operation is the vital factor. Coley (*Keen's Surgery*, vol. iv, p. 50) states that in the first 24 hours the mortality in strangulated hernia should not be over 10 per cent.; in 72 hours it becomes 50 per cent. Naunyn (*Ibid.*, p. 645), in an analysis of 288 cases of ileus, states that recoveries within 48 hours were 75 per cent., but on the third day only 35 to 40 per cent. recovered. Pilcher (*Medical News*, 1902) reports 40 cases of acute intestinal obstruction due to gall-stones with a mortality of 52.5 per cent.

Da Costa (*Modern Surgery*, p. 976) states that mortality in acute intestinal obstruction is 60 to 70 per cent. and states also that prompt diagnosis and operation would much reduce this.

Ruge (*Archiv. f. klin. Chir.*, 1910-1911, xciv, pp. 711-760), in a report of Korte's Hospital cases of obstruction following appendicitis, reports a mortality of 50 per cent. in early obstruction, *i.e.*, immediately following upon the inflammatory process, and 45.8 per cent. in cases due to late or old adhesions. He reports in all 44 cases. J. V. Brown (*Surg., Gynec. and Obst.*, 1911, xii, p. 186) reaches the same conclusions as to the unnecessarily late operations in acute intestinal obstruction in a study of 59 cases in his experience. The only author whose experience seems not entirely to coincide with these facts is Woolsey (*Trans. Amer. Surg. Assoc.*, 1910, xxviii, p. 270), who in 26 cases of acute intestinal obstruction found that the average duration of the illness before operation had been rather less in the nine fatal cases than in the seventeen which recovered.

A more detailed analysis of the different groups of cases brings to light certain definite features concerning each group.

As to sex, our cases were divided fairly evenly, 144, or 52 per cent., being females, and 134, or 48 per cent., being males. Evidently complications arising from disease of the female pelvic organs slightly overbalanced the more frequent occurrence of hernia and disease of the appendix in the male.

Of special groups as regards etiology we find that hernias and post-operative and post-inflammatory adhesions furnish 253 of the 276 cases of obstruction.

## DEAVER AND ROSS

There were in all 156 cases of strangulated hernia, or 56.4 per cent. of the total.

These were subdivided as follows:

Strangulated inguinal hernia .....	77
Strangulated femoral hernia .....	50
Strangulated umbilical hernia .....	21
Strangulated ventral hernia .....	7
Strangulated subdiaphragmatic .....	1

Of the 77 strangulated inguinal hernias, 57, or 74 per cent., recovered, and 20, or 26 per cent., died. Of the 50 cases of strangulated femoral hernia, 36, or 72 per cent., recovered, and 12, or 24 per cent., died. One was noted as improved, possibly spontaneous recovery or reduction; and one is noted as unimproved.

Of the 21 cases of strangulated umbilical hernia, 12 recovered and 9 died, or 42 per cent. Of the seven ventral or incisional hernias, 4 recovered and 3 died, or 42 per cent.

The higher mortality in the umbilical and ventral hernias is accounted for by the frequently observed fact that acute symptoms are often delayed and of lesser severity than in the inguinal and femoral hernias, and the indications for operations not quite as early and definite as in the other varieties of hernia.

Nevertheless, such a mortality in strangulated hernias is appalling. It is true that the average operation for an early strangulated hernia of any of the ordinary varieties does not offer great technical difficulties nor should it be attended by great mortality. The explanation is again to be found in delay before operation. It is our practice at the German Hospital to operate strangulated hernias as soon as possible after admission; the delay, therefore, as in all cases of obstruction admitted to hospitals, is before the admission of the patient. In some few instances the patient may be slow to consult a physician, but generally this is not the case.

In hernia especially the physician has a clue and guide to the cause of the symptoms in the very existence of the hernia. Oversight must be rare, except, possibly, in instances of Richter's hernia. But the hernia, while plainly indicating the source of trouble, also opens the way for delay in the operative treatment of the obstruction by giving an opportunity for an attempt to correct the condition by taxis and manipulation.

Coley gives five minutes as a safe length of time to employ taxis. Many indeed of our cases at the German Hospital have, before admis-

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sion, been subjected to manipulations, often severe and inexpert, extending over many hours and even repeated upon successive days.

When we consider the dangers and difficulties of taxis in strangulated hernia and bear in mind the fact that manipulation has been resorted to in practically every case before its admission to the hospital, we are justified in making it our practice to operate at once upon every strangulated hernia regardless of any other considerations. When ether or chloroform anaesthesia are not safe, local anaesthesia, and in rare cases spinal anaesthesia, will enable us to overcome this difficulty.

Although in our statistics we coincide with Coley in stating that the highest mortality in strangulated hernias is in the umbilical and ventral, our mortality in strangulated inguinal hernias (26 per cent.) was slightly higher than that of the femoral (24 per cent.), the reverse of what this author states. We are also able to substantiate his statement that the mortality is in large hernias and when the sac contains adherent omentum, and we believe that these two factors common to umbilical hernias are important in contributing to the high operative mortality in these cases.

Next to hernia in number are post-operative adhesions, there being in our series 81 cases, or 29 per cent., of the total number. Of the 81 cases, 41 recovered and 40 died, a mortality of 49.3 per cent. This mortality also is high and can only be accounted for by the long average time elapsing between the onset of the disease and operation. While the symptoms of strangulation of a femoral or inguinal hernia are fairly well known to the physician, it would seem that in other cases of intestinal obstruction terminal symptoms only are recognized. It is true that usually a case of obstruction has been diagnosed as colic, acute gastritis, or enteritis, and that a diagnosis of intestinal obstruction is not made until we begin to have the symptoms of toxæmia, peritoneal inflammation and persistent vomiting, often fecal.

In a small percentage of the cases the obstruction occurred during convalescence and while the patient was still in the hospital, when the diagnosis could be made early and treatment promptly instituted. The average time from the first operation to the obstruction was two years and three months. The longest period intervening was twenty years (following a hysterectomy).

Of the 81 cases of post-operative adhesions, 51 followed operations for appendicitis and 44 of this series had had drainage at the original appendiceal operation. Each drainage case can safely be held to mean a case in which operation was delayed beyond the time of election. In line with endeavors to prevent instead of treating avoidable surgical

conditions, nothing is more important than to forestall the development of pus within the peritoneal cavity. Of the 51 cases, 27 died. A large percentage at least of these patients would never have had adhesions or the consequent obstruction had they been operated upon early in the appendiceal attack and had drainage not been necessary.

Seventeen cases are stated to have been due to post-operative adhesions, the primary cause not being given.

Fourteen followed operations upon the female pelvic organs, hysterectomies, salpingo-oophorectomies, etc. A certain number of such cases are now doubtless avoided by the greater care exercised in covering raw surfaces, stumps, etc.

Post-inflammatory adhesions were 16 in number. The term is used to designate new adhesions from an inflammatory or peritonitic process. Of these 11 died, a mortality of 68.7 per cent. This is partly due to the weakened and septic condition of the patients at the time of operation and partly due to the difficulty of diagnosis. Our results must always be in question in these cases. Our only hope is in minimizing the cases of peritonitis and of resulting obstruction. Most of such cases occur after operation for appendicitis in its later stages.

A more difficult post-operative condition to explain is adynamic ileus, of which there were 2 cases, one recovering and one dying. In the absence of a septic cause excessive handling of the viscera may be held to account for it. A more probable explanation is the occurrence of a thrombosis of the mesenteric veins.

There were three cases of fecal impaction with two deaths, a mortality of 66 $\frac{2}{3}$  per cent. Fecal impaction generally occurs in elderly people and often much time elapses before operation. The onset and course are more or less insidious and the patients have usually been treated vigorously by purges, starvation, enemata, etc. Moreover, operative intervention very occasionally leads to enterostomy and colostomy, and this in itself is an unfavorable factor. One case of acute obstruction is recorded as having been caused by congenital bands. Of late years so-called "congenital" bands have received an increasing amount of attention. We believe that bands of extent great enough to produce obstruction are rarely congenital—that they are practically always due to subacute or unrecognized attacks of peritonitis.

There were five cases of volvulus, of which three recovered and two died, or 40 per cent. This is a condition not very frequent and generally not definitely diagnosed before operation. The sudden onset and rapid development of symptoms, however, are always sufficient to



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make clear the fact that some abdominal catastrophe demanding surgical intervention has occurred.

The same is true of intussusception in adults, of which there were two cases in this series; one recovered and one died. The case which recovered was a most interesting one. The intussusception occurred during typhoid fever, was correctly diagnosed and promptly operated. It has been elsewhere reported by one of us in conjunction with Dr. H. F. Page (*Amer. Jour. Med. Sci.*, December, 1907).

There were eight cases of acute obstruction complicating carcinoma of the sigmoid. It is not to be expected that in such cases recovery could occur.

Taken as a whole, numbers of cases in which adequate records were kept show certain interesting points in symptomatology. In 63 cases, from 1908 to 1912 inclusive, with records of the vomiting, there were 35 recoveries and 28 deaths. In the cases recovering 5 only had reached the stage of fecal vomiting, but the average length of time the patients had been vomiting was two days and one hour. Of the 28 cases dying, 14 had fecal vomiting and 14 non-fecal vomiting only. The average duration of the vomiting had been two days and sixteen hours.

It would seem almost impossible that a patient with persistent uncontrollable vomiting with other symptoms of obstruction should be allowed to continue ill for over two days without a diagnosis or appropriate treatment.

In ninety cases, 1908 to 1912 inclusive, in which a record was kept of the fecal evacuations, 52 were cases that recovered and 38 died. In the recovered cases bowel movements had been absent on an average for two days and twelve hours and in those that died, three days and five hours. These figures point, as do the previous ones, to inexcusable delay, for in practically every case vigorous means had been adopted to produce an emptying of the bowel. Here we may well sound a note of warning against misinterpreting evacuations of the lower bowel only as a result of enemata, especially when the colonic contents are emptied by a high enema.

A review of the entire mass of statistics upon this series of cases makes it evident that in almost every instance, in spite of symptoms so plain as to be pathognomonic, diagnosis has been tardy and operation delayed. Prompt diagnosis and immediate operation will reduce the mortality in acute intestinal obstruction to a mere fraction of that encountered at present.

## PRESERVATION OF THE ILIOHYPOGASTRIC NERVE IN OPERATION FOR CURE OF INGUINAL HERNIA \*

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WHEN in 1890 Bassini described his operation for the cure of inguinal hernia, he established an epoch in the treatment of that condition. The splitting of the aponeurosis of the external oblique muscle is an essential part of his procedure, for it enables the operator to ligate the sac at a high level and to properly approximate and suture the structures which form the posterior wall of the reconstructed inguinal canal.

Bassini's operation, or some allied procedure which entails a similar exposure of the tissues, has been very generally adopted by surgeons. The splitting of the external oblique aponeurosis is even practised by those surgeons who believe that the essential step in operation is the high ligation and ablation of the sac, and that suturing the underlying tissue is unnecessary. This is exemplified by Murray,<sup>1</sup> of Liverpool. In operating upon children, some surgeons do not split this aponeurosis, since they believe that in these little patients a sufficiently high ligation of the sac is possible without it; this exception, however, is not important; in the vast majority of hernia operations this aponeurosis is split so as to obtain suitable access to the subjacent tissues.

The improvement in results which has accompanied the adoption of the modern methods of operation for hernia has been remarkable: In 1886, Wood<sup>2</sup> reported 27 per cent. of relapses and, in 1890, Bull<sup>3</sup> reported 36 per cent. and advocated the abandonment of the term "cure," as then used.

While in using the modern methods, Bassini,<sup>4</sup> Judd,<sup>5</sup> Coley and Bull,<sup>6</sup> and Murray<sup>1</sup> report, respectively, 2.8 per cent., 2.5 per cent., .8 per cent. and 1.7 per cent. of recurrences. If we study hospital operation records, we find confirmatory evidence: for instance, there have been 1020 operations for hernia in Roosevelt Hospital since January, 1910. Only 12 of these hernias were recurrences, and in only 2 of the 12 had previous operation been done at that institution. These results surely justify the modern procedure, and we may be well assured that

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the splitting of the external oblique aponeurosis and gaining access to the subjacent tissues is a well established surgical procedure.

Although the percentage of recurrent hernias is small, the total number of hernia operations is now very large. In the month of October, 268 operations for hernia were posted on the bulletin board at New York Academy of Medicine, in a total of 2697 operations, thus indicating that nearly 10 per cent. of the surgical operations of the present time are done for the relief of hernia. When we consider this vast number of operations and the evident fact that the rate of recurrence among operators at large must be greater than that above recorded, we must appreciate that there are enough recurrences to be worthy of careful study.

It is notable that a large proportion of relapses come in the form of direct hernias. Judd<sup>7</sup> writes of the relapses coming just above the pubic bone. Four of Bassini's seven recurrences were direct, the form of the fifth was not stated and the remaining two are referred to as "bulgings," not true hernias. Downes,<sup>8</sup> in studying cases with recurrent hernia who have applied for relief at The Hospital for Ruptured and Crippled, states that a large proportion of them are "direct." The majority of the recurrences which the writer has seen have been in the form of slight "direct" bulgings. One would naturally expect this since the operation for the cure of hernia should leave the region of the internal ring better protected than the lower part of Hesselbach's triangle.

With these considerations in mind we may well ask whether there are any special precautions which should be practised and taught. There are at least two considerations:

1. Adequate suture.
2. Preservation of nerve supply.

*Adequate Suture.*—Much attention has been given to this subject, Coley<sup>9</sup> says: "I believe the lowermost suture is one of the most important in the series. My own practice is to insert the suture in such a way as to include the reflected portion of the external oblique aponeurosis as well as the conjoined tendon and the transversalis fascia." He puts 4 or 5 stitches behind the cord. When the conjoined tendon and the fibres of the internal oblique and transversalis muscles are weak and attenuated—a condition which has been especially studied by Blake,<sup>10</sup> Bloodgood<sup>11</sup> and Downes—it is advantageous to bring down a part of the rectus muscle and possibly to liberate a portion of the internal oblique from the transversalis fascia so as to make a reënforced suture line possible.

*Preservation of Nerve Supply.*—The accompanying drawing (Fig. 1), which is adapted from Spalteholz, shows the nerve supply of this region.

The twelfth dorsal, the iliohypogastric, and the ilioinguinal nerves curve around the lower part of the back and abdomen. They contain both motor and sensory fibres and supply the muscles, peritoneum, fascia and skin. The iliohypogastric nerve is situated between the other two and communicates with them in various places—when it is large, they are small, and when it is small they are found to be proportionately enlarged. They give off motor fibres to the transversalis, internal and external oblique and rectus muscles, and influence the nutrition of the parts which they supply.

Your attention is especially called to that part of the iliohypogastric nerve which crosses the field of operation as exposed by the splitting of the external oblique aponeurosis. Fig. 2 illustrates this.

In incising and turning back this aponeurosis, two nerves may be found,—the ilioinguinal usually lies well down toward Poupart's ligament and can easily be avoided; moreover, it emerges at the external abdominal ring and is distributed to the integument of the scrotum and upper and inner part of the thigh and, hence, has very little importance.

The iliohypogastric nerve,\* however, runs directly across the operative field. During a period of several years I have had the opportunity of seeing a great many hernia operations done by many operators and am confident that this nerve is frequently cut. This cutting is usually unimportant but it may be very important in the small proportion of cases who are likely to have recurrences, and they are the ones under consideration in this paper. The nerve is generally large enough to show very distinctly. It runs into the aponeurosis of the external oblique

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\* This nerve has been studied in detail from various view-points. The flat abdominal muscles are supplied by the lower five intercostal nerves, the iliohypogastric and the ilioinguinal, thus obtaining localized action in different parts of the muscle. Fibres are given off from these nerves as they course through the muscles. These fibres can be seen if careful dissection is made. They were dissected and seen in the wound area before this paper was written. Since then sterilized faradic electrodes have been applied to the nerve during operations and localized contraction has been obtained in those parts of the internal oblique and transversalis muscle which are used in the reconstruction of the posterior wall of the inguinal canal. Serial microscopical sections have also been made and they show the small fibres of the nerve between the muscle bundles near the main trunk.

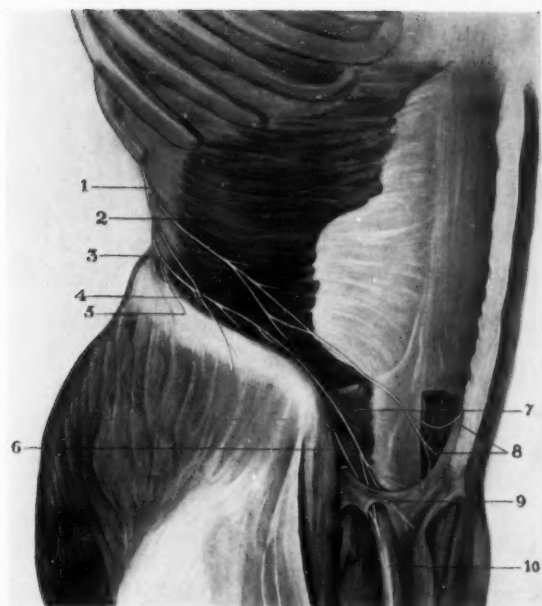


FIG. 1.—Nerve supply of the lower part of the abdominal wall (adapted from Spalteholz). 1, N. intercostalis XII; 2, M. transversus abdominis; 3, N. iliohypogastricus; 4, ramus muscularis; 5, ramus cutaneus lateralis n. iliohypogastrici; 6, N. ilioinguinalis; 7, M. obliquus internus abdominis; 8, rami cutanei anteriores n. intercostalis XII; 9, annulus inguinalis subcutaneus.

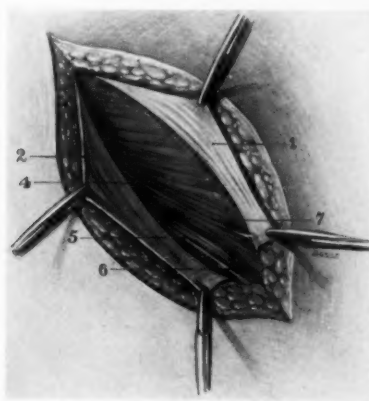


FIG. 2.—1, aponeurosis of external oblique muscle turned upward; 2, aponeurosis of external oblique muscle turned downward; 4, internal oblique muscle; 5, ilioinguinal nerve; 6, cremaster muscle; 7, iliohypogastric nerve.





## ILIOHYPOGASTRIC NERVE IN INGUINAL HERNIA

muscle about an inch above the external abdominal ring. Those fibres which supply sensation to the skin are unimportant, but those which are distributed to the external oblique aponeurosis, the internal oblique and transversalis muscles, and to the transversalis fascia may be important at the time when healing is taking place.

It always seems an anomaly that the internal oblique and transversalis muscles and transversalis fascia should form a permanent union with Poupart's ligament. Such union is denied by some surgeons. Many of us, however, when operating for recurrent hernia, have seen it throughout at least a large part of the suture line. But if we are to expect a good union between these "alien" elements, we should surely leave them all the vigor that we can and should not weaken them during this period of healing by depriving them of their natural nerve supply.

The nerve may be easily seen and avoided,—it is usually best to make the first opening in the aponeurosis by a knife cut,  $1\frac{1}{2}$  inches above and external to the ring, and then slip curved scissors through this opening and push nerve and muscle well back before proceeding with the incision.

Little attention is given to the subject of nerve injury in the descriptions of hernia operations, and the ilioinguinal and genitocrural nerves have received much more than their share of this scant notice. They are much less important than the iliohypogastric.

An incision through the aponeurosis above the external ring, instead of through it, has been advocated; in this incision, the nerve supply may be conserved, but, on the contrary, it may be sacrificed.

In lapping the aponeurosis of the external oblique, as is done in several forms of operation, it is possible to interpose an aponeurosis which is a serious bar to the reunion of severed nerve fibres.

*Summary.*—A terminal branch of the iliohypogastric nerve of considerable size is exposed in the operation for inguinal hernia when the aponeurosis of the external oblique muscle is split and laid open. This branch is easily severed or otherwise injured in the operation. This injury is usually unimportant. Since, however, security against relapse of the hernia depends in large part on the vitality of the parts to which this nerve goes, its injury should be avoided.

The percentage of recurrences after operation for the cure of hernia is small, but the total number of recurrences is considerable since so many operations are done. In the effort to lessen the number of relapses, proper suturing is more important than the preservation of the nerve, but the nerve surely has a definite influence and should not be sacrificed.

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## COMPLETE FRACTURE OF THE LOWER THIRD OF THE RADIUS IN CHILDHOOD, WITH GREENSTICK FRACTURE OF THE ULNA \*

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WHILE fractures of both bones of the forearm in childhood are frequent and well-recognized, there is one variety that, in its mechanism, site, and characteristics, is as definite a clinical entity as is Colles's fracture, and yet it has not been differentiated in the text-books or in the literature from the other indifferent fractures of the forearm. I refer to complete fracture of the radius with incomplete greenstick fracture of the ulna in the lower third of their shafts (Fig. 1). The cause is quite constantly a fall *while in motion*, most commonly either off skates or a bicycle. The deformity consists of displacement of the lower fragment of the radius to the dorsum and laterally, and bending of the ulna with concavity toward the radius, the radial portion of the fibres of the ulna at its site of fracture being compressed but not torn asunder, the inner fibres only being separated. I shall endeavor to show that about this peculiar and characteristic incomplete greenstick fracture of the ulna hinges the maintenance of the displacement, and also the correct method of reduction. The following two cases are typical:

CASE I.—H. H., male, aged fourteen years, school-boy, white, presented at the Surgical Out-patient Department of the University Hospital (Case record 40,201) on April 2, 1914, with the history of having fallen two days previously, *while skating*, upon the outstretched right forearm.

*Clinical Diagnosis.*—Fracture of radius and ulna shafts, lower thirds, that of the radius being complete and with displacement, and that of the ulna being incomplete and with diminution of the normal external concave curve. Skiagram showed for the radius in the anteroposterior view a transverse dentate line of fracture  $1\frac{1}{8}$  inches above the epiphyseal cartilage, with lateral shifting of the distal fragment, one-third diameter; and in the lateral view, displacement of the same fragment dorsally, two-thirds diameter; and for the ulna a transverse greenstick line *incomplete externally*, at a higher level ( $\frac{7}{8}$  inch) than that of the radius, and with bowing of the ulna concave externally (Figs. 1 and 2).

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A study of this fracture in the skiagram not only reveals the mechanism of production, but also furnishes a clue to the mechanism of reduction. The deformity leads one to anticipate difficulties in complete reduction, but it is very simple. In the first instance, it is evident that the brunt of the vulnerating force was borne by the radius, whose fracture is complete, and that there was sufficient force remaining to produce the greenstick fracture of the ulna. The inner fibres of the ulna were ruptured by tensile stress, whilst the outer fibres underwent compressive stress, the force thus stopping short of causing a complete fracture of this bone. *These intact outer fibres of the ulna maintained the position the bones were in when the force ceased to act, and therefore presented the chief obstacle to reduction.* It is patent that *in order to reduce the fracture, attention must be directed chiefly toward overcoming the vicious bowing of the ulna, and that this can be accomplished only by rupturing the still intact outer fibres*, so that alignment of the inner border of the ulna may be restored, which means conversion of the greenstick into a complete fracture. This having been done, *the radial fragments, aided by a little pressure, will reduce themselves automatically.* Acting upon this analysis of the fracture, the complete reduction of the fragments, as shown in the second skiagram (Figs. 3 and 4), was attained. The criterion of reduction, then, must be the restoration of the alignment of the inner border of the ulna.

CASE II.—H. M., male, aged thirteen years, school-boy, white, presented at the Surgical Out-patient Department of the Hospital of the University of Pennsylvania (Case Record 41,221) on July 22, 1914, with the history of having tripped five days previously down three steps, turning a somersault, and landing upon right forearm.

*Clinical Diagnosis.*—Complete fracture in lower third of radius with displacement, and greenstick fracture of ulna at a slightly higher level. Skiagram showed for the radius in the anteroposterior view (Fig. 5) a transverse dentate line one inch above the epiphyseal cartilage, with displacement of upper end of distal fragment laterally, one-third diameter, and in the lateral view (Fig. 6) displacement of upper end of distal fragment dorsally one-half diameter. The ulna showed in the anteroposterior view a transverse greenstick line  $1\frac{1}{2}$  inches above the epiphyseal cartilage, *incomplete externally*, and slight bowing of distal fragment with concavity toward radius. In the lateral view there is no displacement.

Under nitrous oxide gas anæsthesia the greenstick fracture of the ulna was made complete, the outer, unbroken fibres rupturing





FIG. 1.—Type of "special" fracture of radius and ulna (anteroposterior view). The radius is involved by a transverse dentate line,  $1\frac{1}{4}$  inches above the epiphyseal cartilage. The distal fragment is shifted laterally, one-third diameter. The ulna is involved by a transverse greenstick line, incomplete externally, at a higher level ( $\frac{3}{4}$  inch) than that of the radius, and with bowing concave externally. See Case I.

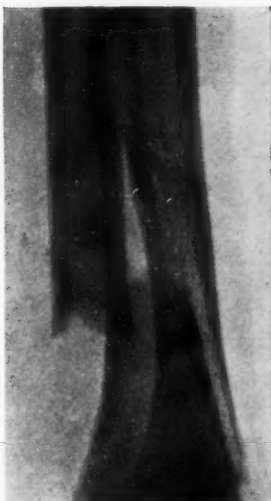


FIG. 2.—Lateral view of radius and ulna in Case I. The distal fragment of the radius is displaced dorsally, two-thirds diameter. There is slight dorsal displacement of the ulna.



FIG. 3.—After reduction (anteroposterior view). Note complete rupture of outer fibres of ulnar fracture, with consequent straightening of inner border of ulna and automatic shifting of displaced distal fragment of radius into good position. Compare with Fig. 1.



FIG. 4.—After reduction (lateral view). Fragments reduced to their normal position. Compare with Fig. 2.



FIG. 5.—A second typical case of "special" fracture of radius and ulna (anteroposterior view). The description corresponds to that of Fig. 1, although both bones are fractured at a more distal ( $\frac{3}{8}$  inch) level. By placing a ruler along the inner border of the ulna the outward bowing of this bone, distal to the seat of fracture, is accentuated. See Case II.



FIG. 6.—Lateral view of radius and ulna in Case II. Note dorsal displacement of distal fragment of radius,  $\frac{1}{2}$  diameter, with greater angulation than in Fig. 2. No displacement of ulna.



FIG. 7.—After reduction; anteroposterior view. Again the outer fibres of the ulnar fracture have been completely ruptured with the result that the alignment of the inner border of the ulna has been restored and the displaced radial fragment shifted in place. Restoration of alignment of inner border of ulna may be demonstrated by a ruler. Compare with Fig. 5.



FIG. 8.—After reduction; lateral view. Distal fragment of radius still angulates slightly backward, but this was corrected with ease at the next dressing. Compare with Fig. 6.

## FOREARM FRACTURES IN CHILDHOOD

with an audible snap. The fragments of the radius adjusted themselves automatically into place. Two splints were applied, a volar bond and a dorsal straight, and the forearm was placed in a triangular sling. Skiagram (Figs. 7 and 8) showed that reduction was complete, *the alignment of the inner border of the ulna having been restored.*

This case was so similar to the first case in the mechanism of production, the findings, and the mechanism of reduction, that I looked over our records to gauge its frequency. A study of these previous cases, together with a closer investigation of cases reporting subsequently forced me to the conclusion that here *we are dealing with a fracture fully as characteristic and significant as Colles's fracture in adults.* In other words, this fracture is to childhood what Colles's fracture is to adults. Colles's fracture is comparatively rare in childhood, having been found in but four per cent. of cases in this series, and occurs at an older age than fracture of both bones in their lower third.

Malgaigne recognized that greenstick fractures are more common in the forearm than elsewhere, and are usually due to a fall upon the hand. The importance of reduction is exceptionally great, not only from the stand-point of epiphyseal growth, but also from that of rotation of the radius, which may be easily destroyed by displacement or non-union. The teaching that a bad anatomical result does not always imply a bad functional result is baneful, for it furnishes an excuse to be satisfied with inferior anatomical reduction. On the contrary, the idea expressed by Mr. Robert Jones, of Liverpool, that a bad anatomical result gives good functioning in only 29.7 per cent., but that a good anatomical result gives good functioning in 90.7 per cent. of cases, is to be endorsed. The same authority also advises that, in addition, the bones be restored to their normal curve. Despite these strong arguments in favor of completing incomplete fractures so as to restore proper alignment, there are some, Cotton among others, who consider it unnecessary, and that it makes it harder to maintain the fragments in the correct position. To this there may be added the theoretical objection that the periosteum might be ruptured or torn up, and that osteoblasts might grow along the blood clot out into the muscles, produce exuberant callus, and subsequently interfere with function. These objections may be met with the observations that many fractures are complete from the beginning, and often show considerable displacement, as in the radius in my case, yet healing without exuberant callus results; that in childhood the periosteum is thicker and tougher than in adults, and hence less liable to be torn; and that, when properly reduced, it is not hard to maintain the

fragments in the correct position—not even so hard as when the fractures are complete from the beginning, since the grip of the greenstick fracture, together with the unruptured periosteum, tends to prevent wide excursion of the fragments from each other during reduction. Of course, in fractures as well as in luxations, it is inadvisable to use an undue amount of force in the act of reduction, for extensive damage might be done.

**ANALYSIS OF CASES.**—One hundred cases of fractures of the radius and ulna in childhood in which the histories were carefully kept were selected from the records of the Surgical Out-patient Department of the University Hospital between January 1, 1912, and September 1, 1914, and afford a fairly rich assortment for study.

**Season.**—Sixty per cent. occurred in the summer months, from May to August, inclusive. In the Spring, bicycles, skating and running become popular. In June and July young human beings revert to the type of their arboreal ancestors coincident with the appearance of luscious cherries upon trees. With the opening of public playgrounds falls from swings furnish many cases. Twenty per cent. occurred in each of the remaining periods of four months, sledding being a contributory factor.

TABLE I

TABLE SHOWING FREQUENCY ACCORDING TO MONTHS AND SEASONS

January.....	3	May.....	10	September.....	8
February.....	6	June.....	10	October.....	6
March.....	5	July.....	28	November.....	4
April.....	6	August.....	12	December.....	2
Total.....	20		60		20

**Age.**—More than two-thirds occurred from nine to fourteen years of age, inclusive. This is the period of greatest and roughest activity in childhood. Both bones and the ulna alone were broken in younger children, while fractures of the radius alone or disjunction of its lower epiphysis occurred on an average in older ones.

TABLE II

TABLE SHOWING FREQUENCY ACCORDING TO AGES

2.....	1	9.....	13	15.....	4
3.....	3	10.....	7	16.....	3
4.....	3	11.....	11	17.....	4
5.....	1	12.....	13	18.....	0
6.....	5	13.....	11	19.....	1
7.....	4	14.....	14		
8.....	2				
Total.....	19		69		12

## FOREARM FRACTURES IN CHILDHOOD

*Sex.*—Four-fifths of the cases occurred in boys, in keeping with their rougher methods of play.

TABLE III

TABLE SHOWING FREQUENCY ACCORDING TO SEX

Males .....	81
Females .....	19

*Cause.*—Fractures of the upper extremity in general and the forearm in particular are the penalty of the erect attitude, and of atrophy of the prehensile function of the forelimb. It seems best to distinguish two classes of falls, those with which momentum is strongly associated, and those in which it is an insignificant factor, the attraction of gravity predominating. In the latter class falls from a height may be given special prominence. A study of these cases shows that the special fracture of the lower third of the radius and ulna, the basis of this paper, is particularly associated with the momentum gained by bicycling, skating, swinging, running, horseback-riding, motoring, and pole-vaulting. Those in which the force is more purely the attraction of gravity are falls from steps, porch or fence rail, chair, bed, high-jump, or merely slipping and falling upon hyperextended, less often hyperflexed, hand. Falls from a height include those from a tree, pole, ladder, or haystack.

*Site.*—As in adults, the lower third of the radius is most frequently fractured. In this series the lower third of both bones or of the radius alone comprised 70 per cent. of the fractures. This circumstance and the fact that the radius in childhood is usually fractured above Colles's site (which is usually taken at from one to one and one-half inches above the lower articular surface of the bone) may be explained in part by the statement of Rixford (*Jour. A. M. A.*, 1913, lxi, 916), that in the long bones of children the medullary canal is smaller than in adults and is especially undeveloped toward the ends, and that the compact bone of the shaft becomes thin much farther from the ends than in adult bones and the cancellous bone extends correspondingly farther from the epiphyses. The following table has been compiled to show the mechanism according to the site of fracture.

The most significant feature of this table is the frequency with which the radius and ulna are both fractured in their lower third, this site being involved in 32, or almost one-third of the cases. Of these 32 cases, thirteen, or almost 50 per cent., conform to the type to which special attention is called in this paper, namely, complete fracture of the lower third of the radius with dorsal and lateral displacement and greenstick fracture of the ulna incomplete on its radial side and with bowing



TABLE IV  
TABLE SHOWING MECHANISM ACCORDING TO SITE OF FRACTURE (See Figs. 9-13)

No. Cases	Site	Gravity Without Momentum	Gravity With Momentum	Falls From Height	Cause Not Given
4	Both bones, upper third.....	3	1	0	0
14	Both bones, middle third.....	7	6	0	1
32	Both bones, lower third.....	15	11	6	0
6	Radius, lower third, and ulna, styloid.....	2	2	0	2
3	Radius, upper third (neck 2, shaft 1).....	2	0	0	1
3	Radius, middle third.....	1	2	0	0
16	Radius, lower third.....	9	4	2	1
16	Radius, disjunction of lower epiphysis, and fracture of ulna, styloid tip (2).....	5	4	3	4
6	Ulna.....	4	1	1	0
100		48	31	12	9

of the lower fragment of the ulna over toward the radius, the displacement of whose lower fragment it thus maintains. In fact, *this special fracture comprises 13 per cent. of all fractures of the radius and ulna*



FIG. 9.—Fractures of radius and ulna (thirds).



FIG. 10.—Fracture of radius (lower third) and ulna (styloid process).



FIG. 11.—Fractures of radius (thirds).

*in this series.* Of these thirteen special fractures at least eight, or almost 66 per cent., were caused by gravity *with* momentum. In the remaining five the nature of the fall unfortunately is not stated in two, was direct

## FOREARM FRACTURES IN CHILDHOOD

violence in two others, and a fall from a ten-foot ladder in the remaining case. Hence, it may be stated that this special fracture is typically *the resultant of the action of gravity with momentum*. A study of the non-typical fractures at this site shows in a general way that falls upon the hyperflexed hand are apt to result in "buckling" fracture of both bones, by which is meant telescoping of cancelli with bulging about the circumference of the fracture and without displacement; that falls upon the hyperextended hand are apt to result in ordinary greenstick fractures of both bones with angulation, and that falls from a height are apt to produce complete fractures of both bones with greater displacement.



FIG. 12.—Epiphyseal disjunction, lower end of radius.

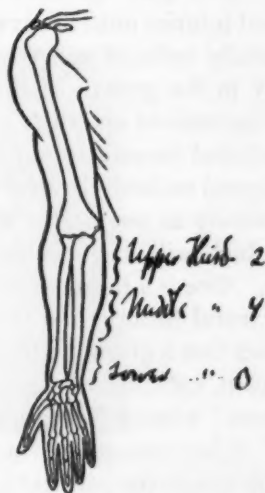


FIG. 13.—Fractures of ulna.

Hence, *knowing the mechanism of the fall enables one to predict with a fair degree of certainty the nature of the injury to the bones*, and I have thus diagnosed the injury in many cases from the history alone. In the smaller number of cases in which the radius is fractured in its lower third alone or in conjunction with separation of the tip of the ulnar styloid the same rules of cause and effect hold good. In the last analysis the extent of fracture hinges upon the intensity of the vulnerating force, and it must be borne in mind that minuter details of mechanism could be elicited if the observer were to see the patients actually falling.

In the sixteen cases of disjunction of the lower epiphysis of the radius all these mechanisms were exemplified. This injury occurs on an average at a later age than the fractures we have been discussing. It is diagnosed clinically by the site of the displacement, if any exist. There

may have been displacement which was reduced by the patient, in which case the history is of great diagnostic importance, and the skiagram being negative is really of positive value. In two of these cases the tip of the styloid process of the ulna was avulsed. There was one case of para-epiphyseal strain, in which injury the epiphysis is partially separated, and one of para-epiphyseal sprain, in which the epiphysis is completely separated but not displaced. These types of injuries conform with the well-known classification of Ollier, and may be diagnosed by the site of "wincing" tenderness, the absence of deformity or of history of deformity, and the skiagram, which shows a widening of the epiphysis, and later on callus formation about the site of injury. Epiphyseal injuries must always be suspected in children and adolescents and carefully reduced and treated just as a fracture, lest there arise deformity in the growth of the bone.

The diagnosis of an injury to the forearm should always be made by careful clinical investigation. It is a great mistake in more than one way to depend exclusively upon the skiagram. *A skiagram must be considered merely as one of the many signs of fracture.* There are two factors which will diagnose 90 per cent. of fractures of the forearm clinically. One is a thorough understanding of the mechanism obtained from a careful history, and the other, "wincing" tenderness. It has been shown that a given mechanism is apt to produce a certain fracture. This, in turn, indicates where to examine for "wincing" tenderness. I use the term "wincing" because more expressive than the adjective "localized." When the site of fracture is reached moderate pressure with a finger tip causes the patient to *wince*: he screws his face up and involuntarily withdraws his arm. This is almost pathognomonic of fracture.

There is another feature to which I believe attention has not hitherto been called. I have recently seen several cases of fracture in childhood in which I was positive of the existence of a fracture on clinical grounds, but in which skiagrams taken from all aspects were apparently negative. Not having been satisfied I decided to await the usual period of callus formation and then have other skiagrams taken, in the meantime treating the cases as fractures. In these several cases I had the satisfaction of seeing typical callus produced. In the first case I wondered if this were a traumatic osteoperiostitis, but my doubts were allayed by the second case, in which there was a complete fracture with callus in the lower third of the radius while the ulnar callus showed only along the radial border of this bone, at a location where it is obvious that traumatic osteoperiostitis could not occur, especially seeing that the injury was produced by indirect violence. Minute scrutiny of the skiagrams now

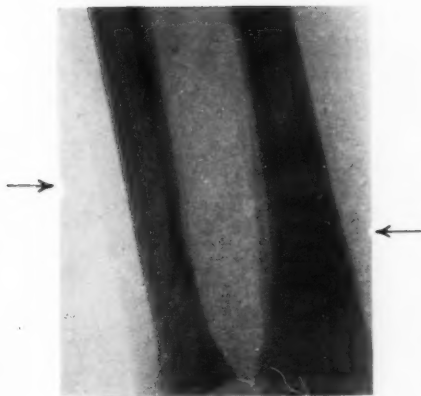


FIG. 14.—The method of diagnosing "first degree" greenstick fractures, patent clinically but obscure in skiagram, by awaiting callus formation. The radial border of the ulna, between the two arrows, shows a strip of callus formation, the lower arrow showing, on close scrutiny, a greenstick fracture. Note callus on radius. Skiagram taken 40 days after injury.





## FOREARM FRACTURES IN CHILDHOOD

revealed a very faint transverse line, perhaps only a few torn cancelli, whose site corresponded exactly to that of the clinically-elicited "wincing" tenderness (Fig. 14). In interpreting this faint line defects in the plate were carefully excluded. I believe that here we are dealing with the first degree of a greenstick fracture—a degree attained by the vulnerating force ceasing to act after it had torn a few cancelli, whereas further action of this vulnerating force would have produced the typical bending greenstick fracture. These cases also emphasize the accuracy of "wincing" tenderness, and its value as an indicator of where to look on the skiagram for a fracture. I believe I present good reasons for considering a skiagram a secondary sign of fracture that is surpassed in value by a careful history and the eliciting of "wincing" tenderness.

I believe that fractures of the radius and ulna or of either alone in childhood are best treated according to the following plan. If reduction be indicated, nitrous oxide gas should be administered for reasons stated above. Attempts at reduction must be repeated until the skiagram shows a satisfactory result. The criterion of reduction of a Colles's fracture or an epiphyseal disjunction is the restoration of the carpal articular surface of the radius to a plane that lies at right angles with the long axis of the forearm. Splints of the proper size are fashioned for the individual case from stout pine board. It is my custom to have at hand for this purpose a stock of boards in lengths and a sharp carpenter's saw. The splints are well padded with non-absorbent cotton, which is retained by a muslin bandage secured by a pin. The padded splint is applied to the forearm and retained, not by plaster, but by a *muslin* bandage. In applying this bandage the first turns are the loosest and the final turns the tightest. The bandage is secured by pins or adhesive strips. The forearm is always bandaged at right angles to the upper arm, lest the upper edge of the bandage cut into the antecubital fossa. A triangular sling is then applied. For fractures of both bones in the upper two-thirds the mid-prone position is liable to result in sagging of the fragments toward the ulnar side, an undesirable circumstance that may be obviated by the position of full supination. The patient reports the next day to insure against ischæmic contracture, and the parent is directed to watch the circulation of the limb by noting the color, temperature, and occurrence of pain, and bring the child around immediately upon the appearance of these disturbances, for it is known that ischæmic contracture may develop within a very few hours. Massage and passive motion are prescribed for the individual case, and the splints removed as soon as firm union is present.

CONCLUSIONS.—(1) There is a fracture of the lower third of the

TABLE V\*  
TABLE OF ONE HUNDRED CASES OF FRACTURES OF THE BONES OF THE FOREARM IN CHILDHOOD  
Group 1. Fracture of Radius and Ulna in Upper Third: 4 Cases

Case	No. of Case Record	Sex		Age	Nature of Fall	Right	Left	Greenstick		Complete		Displacement	Remarks
		M	F					Radius	Ulna	Radius	Ulna		
1	36184	..	+	2	From steps.....	..	+	+	+	..	..	Angulation .....	Dressed in full supination.
2	39755	+	..	13	Upon forearm.....	..	+	..	..	+	+	Of radius .....	Internal angular splint.
3	41263	+	..	10	Upon extended hand.....	..	+	..	..	..	..	Angulation of ulna.	
4	35301	+	..	12	From bicycle.....	..	+	..	..	..	..		
	4	3	1			1	3	3	3	1	1		

Group 2. Fracture of Radius and Ulna in Middle Third: 14 Cases

Case	No. of Case Record	Sex		Age	Nature of Fall	Right	Left	Greenstick		Complete		Displacement	Remarks
		M	F					Radius	Ulna	Radius	Ulna		
5	39275	+	..	9	Jump from tree-stump.....	+	..	+	+	..	..	0	Dressed in full supination.
6	35114	+	..	17	While running.....	+	..	..	..	+	+	Of radius .....	Dressed in full supination.
7	36264	+	..	11	Downstairs.....	..	+	..	..	+	+	Slight volar angulation.	
8	36892	+	..	9	From skates.....	..	+	..	..	..	..	Angulation of ulna.	
9	36078	..	+	9	Upon forearm.....	..	+	+	+	..	..	Slight dorsal angulation.	"Buckling," forearm probably doubled under.
10	36266	+	..	3	From chair.....	..	+	+	+	..	..		Fractured twice before.
11	38342	+	..	9	Slipped, losing balance.....	..	+	..	..	+	+	0	Five weeks old callus present.
12	37475	+	..	7	Upon forearm.....	..	+	..	..	..	..	Slight dorsal angulation.	
13	35446	+	..	14	From horse.....	..	+	..	..	..	..	Slight ulnar angulation.	Treated by gypsum case in Texas.
14	34613	+	..	15	From bicycle into ditch.....	+	..	..	..	+	+		

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15	38253	+	14	From skates.....	+	..	..	..	..	..	Slight volar angulation.	Dressed in full supination.
16	38655	+	13	From skates.....	..	..	..	..	..	..	Slight volar angulation.	
17	37746	..	11	?	+	..	+	..	..	..	Ulna encroached on interosseous space.	
18	35405	+	3	?	..	..	..	+	..	..	Slight lateral angulation.	Ulna incomplete internally.
	14	11	3		6	8	5	6	9	8	11	

Group 3. Fracture of Radius and Ulna in Lower Third: 32 Cases

Case	No. of Case Record	Sex		Age	Nature of Fall	Right	Left	Greenstick		Complete		Displacement	Remarks
		M	F					Radius	Ulna	Radius	Ulna		
19	38092	+	..	15	From bicycle.....	+	+	+	+	+	..	Lateral.....	"Special."
20	38002	+	..	9	From railing.....	+	+	+	+	+	..	Dorsal and lateral....	"Special."
21	40734	..	..	14	From bicycle.....	+	..	..	..	+	..	Slight volar angulation.	"Special."
22	40288	+	..	9	While running.....	+	..	..	..	+	..	Dorsal and lateral....	"Special."
23	38669	+	..	6	From skates.....	+	..	..	..	+	..	Dorsal and lateral....	"Special."
24	40201	+	..	14	Upon hyperextended hand.....	+	..	+	+	+	..	Dorsal and lateral....	"Special."
25	40312	+	..	11	Down 3 steps.....	+	..	+	+	+	..	Volar angulation.	"Special."
26	41221	+	..	13	While running.....	+	..	+	+	+	..	Dorsal and lateral....	"Special."
27	38742	+	..	6	On hyperflexed hand.....	+	..	+	+	+	..	Volar angulation.	"Special."
28	33837	+	..	13	From tree, four feet.....	+	..	+	+	+	..	Volar angulation.	"Special."
29	35873	+	..	11	Landing from pole-vault.....	+	..	+	+	+	..	Volar angulation.	"Special."
30	37376	+	..	16	From haystack.....	+	..	+	+	+	..	Lateral and dorsal.	"Buckling" of radius.
31	37991	+	..	9	Struck dorsum of wrist on ground?	+	..	+	+	+	..	Dorsal.....	"Special."
32	36883	+	..	12	From swing.....	+	..	+	+	+	..	Volar angulation.	"Special."
33	41564	+	..	7	From porch-rail.....	+	..	+	+	+	..	Dorsal.....	"Special."
34	41033	..	+	4	While sledding.....	+	..	+	+	+	..	Dorsal.....	"Special."
35	39890	+	+	13	Fighting.....	+	..	+	+	+	..	Dorsal.....	"Special."
36	41004	+	..	12	Against curb.....	+	..	+	+	+	..	Dorsal.....	"Special."
37	35166	+	..	10	Upon hyperflexed hand.....	+	..	+	+	+	..	Dorsal.....	"Buckling" from hyperflexion.
38	41262	+	..	10	From ladder, 10 feet.....	+	..	+	+	+	..	Dorsal and lateral....	"Special."
39	35224	+	..	12	Backward on hyperextended hand.....	+	..	+	+	+	..	Dorsal of ulna.....	"Buckling" of radius.
40	41488	+	..	14	From skates.....	+	..	+	+	+	..	Dorsal.	"Buckling" of radius.
41	34125	+	..	8	Upon hyperextended hand.....	+	..	+	+	+	..	Volar of radius.	Impact of radius.
42	37129	+	..	11	From tree.....	+	..	+	+	+	..	Dorsal.....	
43	35066	+	..	11		+	..	+	+	+	..	Dorsal.....	

\* The incomplete histories in these groups represent those cases not observed by the writer.

TABLE V.—Continued  
Group 3.—Continued

Case	No. of Case Record	Sex		Age	Nature of Fall	Right	Left	Greenstick		Complete		Displacement	Remarks
		M	F					Radius	Ulna	Radius	Ulna		
44	34925	+	..	8	Upon hyperextended hand.....	..	+	+	+	..	+	Dorsal of radius.....	"Special."
45	35168	..	+	17	Downstairs.....	..	..	..	..	+	+	Dorsal.	"Special."
46	35101	..	..	12	From high jump, 3 feet.....	..	..	..	..	+	+	Dorsal.	"Special."
47	38266	..	+	7	While running.....	..	..	..	..	+	+	Dorsal of radius.....	"Special."
48	36681	..	+	12	From skates.....	..	..	..	..	+	+	Dorsal.....	"Special."
49	37668	..	..	11	From cherry tree.....	..	..	..	..	+	..	Dorsal and mesial.	
50	37822	..	..	9	From tree, 7 feet.....	..	..	+	+	..	..	Dorsal of radius.	
	32	27	5			18	14	10	22	22	10	27	

Group 4. Fracture of Radius (Lower Third) and Ulna (Styloid Process): 6 Cases. Velpeau Fracture

Case	No. of Case Record	Sex		Age	Nature of Fall	Right	Left	Greenstick	Complete		Displacement	Remarks
		M	F						Radius	Ulna		
51	34297	+	..	12	From skates.....	..	+	..	+	..	0	Abrasion of hand.
52	PH 1756	..	+	10	From swing.....	..	..	..	..	..	Dorsal.	Note buckling from hyperflexion.
53	34768	..	+	14	From porch.....	..	..	..	..	..	"Silver-fork."	
54	41416	..	+	12	Downstairs upon hyperflexed hand	..	..	..	..	..	"Buckling" dorsally	
55	37285	+	..	11	?	..	+	..	+	..	Dorsal.	Cause probably hyperflexion.
56	38555	..	..	9	?	..	..	..	..	..	"Buckling" dorsally	
	6	3	3			2	4	3	3	3	5	

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Group 5. Fracture of Radius in Upper Third: 3 Cases

Case	No. of Case Record	Sex		Age	Nature of Fall	Site	Right	Left	Impacted	Complete	Remarks
		M	F								
57	41242	..	+	6	Down 5 steps.....	Neck of Radius....	..	+	+	..	Occasional epiphysis for upper third olecranon present. Head of radius slightly luxated anteriorly. History incomplete.
58	39320	+	..	14	Upon forearm.....	Neck of radius....	+	..	+	..	
59	40520	..	+	11	?	Shaft.....	+	..	..	..	
	3	1	2				2	1	2		

Group 6. Fracture of Radius in Middle Third: 3 Cases

Case	No. of Case Record	Sex		Age	Nature of Fall	Direct Violence		Greenstick	Complete	Remarks
		M	F			Right	Left			
60	38682	+	..	15	From motor.....	+	+	..	+	Oblique, with loose fragment on side of concavity. Incomplete mesially.
61	35802	+	..	4	From cycle.....	+	+	+	..	
62	41164	+	..	12	Boy trod on.....	+	+	+	1	
	3	3	3			3	3	2		



TABLE V.—Continued  
Group 7. Fracture of Radius in Lower Third: 16 Cases

Case	No. of Case Record	Sex		Age	Nature of Fall	Right	Left	Greenstick	Complete	Colles's Displacement	Remarks
		M	F								
63	35872	+	..	6	Upon hyperextended hand.....	..	+++	..	+	0	"Bucking." Impacted.
64	35015	+	..	5	From cherry tree.....	..	+++	..	..	0	
65	34612	+	..	10	From slipping; upon hyperex- tended hand.....	..	+++	..	..	Dorsal angulation.	
66	35075	+	..	13	From bed.....	+	+	+	+	Volar angulation.	"Bucking." Reverse of Colles's from hyperflexion.
67	PH 1640	+	..	14	From fence, striking dorsum on stone.....	..	+	+	+	Dorsal.	
68	PH 1589	+	..	11	From skates.....	+	..	+	+	Dorsal.....	
69	37959	+	..	11	A boy forcibly hyperextended hand.....	+	+	+	+	Dorsal angulation.	"Bucking." Reverse of Colles's from hyperflexion.
70	37030	+	..	13	Upon hyperflexed hand.....	..	+	+	..	Dorsal angulation.	
71	38557	+	..	12	Upon hyperflexed hand.....	..	+	+	..	Reverse volar.....	
72	41117	+	..	9	Upon hyperflexed hand.....	+	..	..	+	+ Dorsal angulation.	"Bucking." Reverse of Colles's from hyperflexion.
73	37948	+	..	17	?	..	+	+	..	+ Dorsal angulation.	
74	36864	+	..	14	From skates upon hyperextended hand.....	..	+	+	..	+ Dorsal angulation.	
75	35907	+	..	11	From skates.....	..	+	+	..	+ Dorsal.	"Bucking."
76	34413	+	..	17	Upon hyperextended hand.....	+	+	+	+	+ Dorsal.	
77	38642	+	..	15	From chair.....	..	+	+	..	+ Dorsal angulation.	
78	41457	..	+	6	From chair.....	..	+	+	..	+ Dorsal angulation.	
	16	14	2			5	11	11	5	5 11	

# FOREARM FRACTURES IN CHILDHOOD

Group 8. Strain, Sprain, and Disjunction of Epiphysis at Lower End of Radius

Case	No. of Case Record	Sex		Age	Nature of Fall	Right	Left	Juxta-epiphyseal		Dorsal Displacement	Separation of Tip of Ulnar Styloid	Remarks
		M	F					Strain	Sprain			
79	41246	+	+	13	From skates on hyperextended hand	..	+	..	..	+	..	One month old; treated elsewhere for contusion. History incomplete.
80	37996	..	..	9	Upon hyperextended hand	+	..	..	..	+	..	Annular tenderness. History incomplete.
81	38115	+	+	14	?	?	?	..	..	+	..	One year old; treated elsewhere for sprain; function impaired.
82	38604	+	+	14	While running, upon hyperextended hand	+	+	..	..	+	..	History incomplete.
83	40542	+	+	16	Upon hyperextended hand	+	..	..	..	+	..	History incomplete.
84	41146	+	+	11	Upon hyperextended hand	+	..	..	..	+	..	Also, chip separated from radial border of metaphysis.
85	40724	+	+	12	?	+	?	..	..	?	..	Treated elsewhere as sprain.
86	40171	+	+	10	From skates	+	+	..	..	?	..	Annular tenderness.
87	39687	+	+	14	From pole, 15 feet	+	+	..	..	?	..	
88	35194	+	+	13	From pole, 15 feet	+	+	..	..	?	..	
89	36125	+	+	10	From trapeze	..	+	..	..	?	..	
90	35983	+	+	13	Down steps upon hyperflexed hand	+	..	..	..	+	+	
91	41521	+	+	12	From cherry tree upon hyperextended hand	+	+	..	..	?	+	
92	41103	+	+	19	Upon hyperextended hand	+	+	..	..	?	+	
93	40657	+	+	13	Upon hyperextended hand	+	+	+	+	0	+	
94	41122	+	+	9	From cherry tree, 15 feet	+	+	+	+	0	+	
16		15	1			8	6	1	1	7	3	

TABLE V.—Continued  
Group 9. Fracture of Ulna in Upper Third: 2 Cases

Case	No. of Case Record	Sex		Age	Nature of Fall	Right	Left	Site	Greenstick	Complete	Remarks
		M	F								
95	34140	+	..	11	Upon hyperextended hand.....	+	..	Just below greater sigmoid cavity ..	+	..	Line runs from above and behind downward and forward.
96	40876	+	..	12	Playmate fell on forearm.....	+	..	Shaft.....	..	+	
	2	2	0			2	0		1	1	

Group 10. Fracture of Ulna in Middle Third: 4 Cases

Case	No. of Case Record	Sex		Age	Nature of Fall	Right	Left	Displacement	Greenstick	Complete	Remarks
		M	F								
97	35000	..	+	4	From couch.....	..	+	0	+	..	16 days old; brought because of persistence of pain. Diagnosed contusion elsewhere. Direct violence preponderates in fractures of ulna. No luxation of head of radius in this series.
98	35153	+	+	7	From swing.....	..	+	+	..	+	
99	34054	..	+	14	Struck against log.....	..	+	+	..	+	
100	37920	+	..	9	From tree.....	+	..	+	..	+	
	4	2	2			1	3	3	1	3	

## FOREARM FRACTURES IN CHILDHOOD

radius and ulna peculiar to childhood and which constitutes about 13 per cent. of fractures of the forearm. This fracture commonly occurs before the age of puberty, is most frequently encountered during the summer months, and is caused usually by the effects of gravity plus momentum. It is characterized by complete fracture of the radius with dorsal and lateral displacement of the lower fragment and by incomplete greenstick fracture of the inner half of the ulna, usually at a higher level, the outer half remaining intact and maintaining the deformity of the ulna, which is a bowing of the lower fragment toward the radial side and which, in turn, maintains the displacement of the distal fragment of the radius. In reducing this fracture the aim must be to convert the incomplete greenstick into a complete fracture by forcibly rupturing the still intact outer fibres, thereby enabling restoration of alignment of the distal fragment of the ulna with that of the axis of the bone, the distal fragment of the radius coincidentally shifting itself automatically into position. The criterion of reduction is the restoration of the normal alignment of the inner border of the ulna.

(2) Fracture of the lower third of both bones and of the radius alone comprise 70 per cent. of fractures of the forearm in childhood. The site of the fracture and its variety may often be predicted by a knowledge of the history and mechanism of the fall.

(3) Injuries to epiphyses, whether strain, sprain, or disjunction, should be recognized and treated as fractures because of their importance in the growth of the bones and because epiphyseal injuries often predetermine infections, typically tuberculous.

(4) Diagnosis may be established clinically by the mechanism and "wincing" tenderness. If deformity exist it is unjustifiable to elicit further signs of fracture. Skiagrams are of corroborative value, but by no means the final arbiters. Their chief value is in showing the degree of deformity and its presence after reduction.

(5) Owing to the delicacy of the radius and ulna in childhood fracture is the rule, while contusion and sprain are the exceptions.

(6) Treatment is begun by the administration of an anæsthetic if deformity exist. Otherwise a carefully prepared and padded splint (or splints) is applied firmly and without undue pressure. Skiagraphic control of reduction is important. Massage and passive motion are adapted to the individual case. The splints must be removed as soon as there is firm union.

(7) Operation is indicated only when conservative treatment is admittedly a failure. It will seldom be necessary. The inlay method of Albee should be used instead of an array of metal fixtures.

## THE REFORMATION OF GALL-STONES AFTER OPERATION

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NOTWITHSTANDING the relative frequency of clinical recurrences following gall-stone operations, actual reformation of stones in the gall-bladder or ducts following their removal by operative methods is of extremely rare occurrence. This is proven both by the observations of surgeons having a large experience in gall-stone surgery and by the remarkably small number of reported cases in the literature.

I believe, therefore, that the following case of definite reformation of stones in the gall-bladder after cholecystostomy is of sufficient interest to warrant reporting, together with a general summary of the available data concerning this phase of gall-stone surgery.

Mrs. M. G., age thirty-five, referred by Dr. Geo. P. Harran, admitted to Ellis Hospital January 19, 1909, for an incomplete abortion. Soon after her admission to the hospital the foetus and placenta were passed without operative interference and from this trouble she made a prompt recovery. Several days later, however, she developed symptoms of subacute intestinal obstruction with pain referred to left lower quadrant. These attacks recurred on several occasions before her first operation.

*First Operation* (February 26, 1909).—Low median incision. Sigmoid adherent to region of Poupart's ligament by one firm band of adhesions which was apparently the cause of the obstructive symptoms. Right ovary slightly adherent. Appendix negative. Loosened adhesions. Excised right tube and appendix. Gall-bladder palpated and found full of large stones. High right rectus incision. Cholecystostomy. A number of large faceted stones removed and gall-bladder drained. Taite-Ochsner technic. Ducts free. No impacted stones. No noteworthy cholecystitis.

Two months after her first gall-stone operation she was able to return to work and for a period of five years she felt perfectly well and so reported on several occasions in answer to letters inquiring as to her post-operative condition. In April, 1914, she had her first recurrence of abdominal pain centred in the epigastrium and accompanied by much "pressure against her heart." The first attacks lasted from one-half to one hour with free intervals of about a week, but later the pains came on every few hours and the more severe attacks were accompanied by nausea and vomiting. During these attacks she again had considerable pain in the left lower quadrant.

*Physical Examination*.—Well-developed, well-nourished woman. Chest negative. Nicely healed scars of old median and high right rectus abdominal incisions. Marked tenderness in right epigastrium and left



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lower quadrant. Marked tenderness in Boas' point posteriorly. Also in left inguinal region. Uterus pulled toward the left side with a tender mass in left fornix. Right fornix free.

*Diagnosis.*—Gall-stones. Left chronic salpingitis.

*Second Operation* (June 3, 1914).—Ether-novocaine anæsthesia, low median incision, left tube and ovary found bound together in a mass surrounded by adherent sigmoid, two loops of small intestine adherent by stretched adhesions in region of old low median scar. Omentum adherent to region of scar of old gall-bladder incision and around gall-bladder, which was felt to contain two medium-sized and a number of small stones. Excised left tube and ovary. High right rectus incision, loosened adherent omentum from gall-bladder and region of incision and excised gall-bladder, leaving clamp on stump of cystic duct. Vioform gauze and rubber tissue drain placed around this clamp. Ducts negative.

*Gross Pathology.*—Specimen consists of gall-bladder excised through the cystic duct together with a portion of the old abdominal scar which is adherent to the summit of the fundus of the gall-bladder. The peritoneal surface of the gall-bladder is of a dull whitish color and roughened by a few fine tags of fibrous tissue. On section the gall-bladder is found to contain thin golden-yellow bile and calculi of three distinct sizes, as follows: two light yellow, mulberry type stones each measuring 1 cm. in diameter; fifteen much smaller stones averaging only 2 mm. in diameter, but each of a distinct mulberry type and of the same color as the larger stones; in addition, there are numerous soft yellowish concretions averaging only 1 to  $\frac{1}{2}$  mm. in diameter. The mucosa is red to reddish-yellow in color with marked prominence of the papillæ.

*Microscopic Pathology.*—Numerous minute epithelial defects over summits of papillæ. All sections show more or less subepithelial leucocytic infiltration while some sections show a well-marked lymphocytic and polymorphonuclear infiltration of all coats.

*Diagnosis.*—Recurrent cholelithiasis, cholecystitis, chronic left salpingitis, intestinal adhesions.

Uneventful post-operative recovery.

**TRUE AND FALSE RECURRENCE.**—In considering cases of possible recurrence it is necessary to differentiate between the rare cases of true recurrences and the relatively frequent clinical recurrences due to stones overlooked at the first operation. That the latter accident is of frequent occurrence, even in the practice of the most expert operators, is apparent from all statistics dealing with end results in gall-bladder surgery. Thus, Kehr<sup>1</sup> is aware of having, himself, overlooked stones in 2.5 per cent. of 1105 cases operated upon between 1890 and 1909.

McWilliams<sup>2</sup> found that stones had been overlooked seven times in 69 cases operated upon at the Presbyterian Hospital.

Whittemore<sup>3</sup> reports the finding of calculi in thirty secondary opera-

tions following 325 cholecystostomies for calculi performed at the Massachusetts General Hospital.

My own studies<sup>4</sup> of the causes for secondary operations on the biliary tract, covering a large number of cases compiled from the reports of numerous operators, would lead me to believe that stones are overlooked at the first operation in from 2 to 10, or even more, per cent. of cases, depending upon the skill of the operator and the class of cases which he is called upon to treat.

EXPERIENCE OF INDIVIDUAL SURGEONS.—Maurice H. Richardson,<sup>5</sup> in a paper published shortly before his death, said, "Since my first operation on the gall-bladder, in 1886 or thereabouts, I have never seen, so far as I can recollect, a single case of recurring stones—of stones formed when once the gall-bladder had been thoroughly drained. It is unheard of in my experience to open a gall-bladder that has once been drained and to find gall-stones of recent formation, *i.e.*, gall-stones that are soft and bright colored. On the other hand, it is not at all uncommon for me to remove a stone overlooked at the original operation, especially when that operation was performed by a man of small experience."

Kehr,<sup>6</sup> writing in 1911, says that in an experience of 1780 gall-stone operations he has seen only three cases of true recurrence of gall-stones, two after "*zystendysen*" and one after cystostomy, while after cystectomy and hepatic drainage he had never seen a single case.

In tracing the end results<sup>7</sup> in 245 gall-stone cases operated on to 1911, I found only three patients with a history suggesting reformation of stones, but in no instance had the suspicion been verified by a second operation.

TRUE RECURRENCES.—The reported cases of true recurrence may be conveniently classified under the following heads: first, reformation of stones in the gall-bladder following cholecystostomy; second, reformation of stones in the ducts; third, cases in which the new stones have formed upon unabsorbable suture material or threads from gauze tampons used during the first operation; fourth, miscellaneous and doubtful cases.

*Reformation of Stones in Gall-Bladder.*—CASE I (KORTE<sup>8</sup>).—Operation February, 1898, for perforating empyæma of gall-bladder. Two large stones removed and gall-bladder drained. Recurrence of symptoms a year later. Carlsbad treatment with no result. Reoperated four years after first operation and 1121 small stones removed. Recovery after cystostomie and hepatic drainage.

CASE II (McWILLIAMS<sup>9</sup>).—Woman, age fifty-six, operated on March, 1896.

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Appendectomy and cholecystotomy. Gall-bladder shrunk and atrophied and contained four stones. Re-admitted in November, 1899, three years and eight months after operation, saying that she had been perfectly well until three months before, when she began to have severe attacks of colic in right epigastrium. Vomited several times and frequently jaundiced. Second operation: Gall-bladder shrunk and buried in adhesions. Numerous calculi found in gall-bladder. Cholecystotomy. Result six years after operation: Has never had pain in gall-bladder region since. This patient was perfectly well for three years and eight months after the first operation when she developed severe symptoms of calculi which were found to be very numerous at the second operation.

CASE III (WESTBROOK<sup>10</sup>).—Woman, age thirty-five, operated upon May, 1906. Acute cholecystitis. Cholecystotomy. Six faceted stones about  $\frac{1}{2}$  in. in diameter removed. Recurrence of pains one year later. Operated on two years after first operation. Cholecystectomy. Thickened gall-bladder contained eight faceted stones, each of uniform size and color, about the diameter of large peas. When last heard from, two years after the second operation, patient was well.

CASE IV (STANTON).—*Vide infra*.

*New Stone Formation Occurring in Ducts.*—CASE I (KORTE<sup>11</sup>).—Cholecototomy, May 12, 1898, with removal of stones from the common and hepatic ducts. Healed June 15. Complete relief until December, 1899, when there was recurrence of colic with icterus. Reopened February, 1902. Gall-bladder free. Stones again found in choleductus and removed by choledotomy. In this case Korte explored the hepatic duct to the bifurcation with his finger at the first operation, but the prompt recurrence suggests the probability that stones were overlooked above the bifurcation. It is interesting to note that in this case there was no recurrence of stones in the gall-bladder.

CASE II (KORTE<sup>12</sup>).—Operation, August 22, 1901. Cystostomy. Turbid bile and many stones. October 15, 1901, cystectomy. Gall-bladder empty. Small soft concretions removed from cysticus, choledochus and hepaticus. Hepaticus drainage. Hemp-seed sized calculi drained through the tube. Hepaticus irrigations. Carlsbad water and salicylates given. Tube removed in six weeks with prompt closure of fistulae. Soon had recurrence of chills and other symptoms. Again operated on February 24, 1903. Turbid bile with purulent particles found in ducts and a bean-sized soft calculus was removed from the retro-duodenal portion of the common duct.

Death March 11, 1903. Autopsy showed small soft concretions in the intrahepatic ducts similar to those previously found in the drainage.

This cannot be considered a case of true recurrence.

CASE III (KORTE<sup>13</sup>).—Operated on August 13, 1895. Cystostomy. Seven hazel-nut sized stones removed from the gall-bladder and a similar stone from the cystic duct. Also a walnut-sized stone from the dilated common duct. Prompt healing. Seven years without noteworthy symptoms. Reoperated upon December 12, 1902, with icterus, general cachexia ascitis and oedema. Death March 6, 1903. Autopsy. Carcinoma of stomach, peritoneum mesentery and regional lymphatics. In the choleductus was a walnut-sized stone. The ducts were greatly dilated but there were no other stones.

The carcinoma with resulting partial obstruction to the bile flow will account for the reformation of stone in this case.

CASES IV, V and VI.—W. J. and C. H. Mayo<sup>14</sup> mention three cases of recur-

rence of stones in the common duct after removal as follows: "Stones may reform in the common duct after removal. We have had this happen three times after a cholecystectomy had taken away the possibility of the usual site of formation. We have never known recurrence of stones in the common duct after cholecystectomy, except under one or more of the following conditions: the stones removed had originated in the gall-bladder; they had left as a legacy, an infected and thickened common duct; they had given rise to chronic pancreatitis, which in turn interfered with efficient biliary drainage."

CASES VII and VIII.—FLÖRCKEN<sup>18</sup> quotes Korte as having found two additional cases of common duct recurrence following cholecystectomy and choledochotomy.

*New-Formed Stones with Foreign-Body Nuclei. Suture Recurrences.*—CASE I (KEHR<sup>19</sup>).—Woman, age fifty-four. Cholecystostomy, February 23, 1893. Removal of an oval, flat, very hard stone the size of a large bean. After a quarter of a year new attacks of colic that returned every three months. August, 1895; icterus, gall-bladder very large. A stone was passed by rectum and showed in its centre a silk thread.

September, 1895: Cystostomy. Many soft stones of which each enclosed a silk thread.

October, 1895.—Choledochotomy. Several remains of stones, residue of first operation, removed.

CASE II (KEHR<sup>19</sup>).—Woman, age forty-eight, operated on in 1892. Cholecystostomy for cholethiasis. After four years again had colics at intervals of three months for three years. From 1899 to 1903 no symptoms.

December, 1903: New attack. Gall-bladder opened through a little cut in the old scar; there was much thick gall released, no stone found, drainage of gall-bladder. On cleaning out with a piece of gauze a club-shaped stone was withdrawn and after that, with tweezers, a larger one. The stone was 1 cm. long,  $\frac{1}{3}$  cm. thick with club-shaped swelling at the end; enclosed in the centre a silk thread from the operation twelve years before. Color of stone brown.

CASE III (HOMANS<sup>19</sup>).—Woman, age thirty-eight, operated upon April 6, 1895. Cystostomy. Healed in five weeks. Trouble again showed itself in December, 1896. At a second operation, January 18, 1897, seven stones were found in bladder. Three of these, the size and shape of a bean, lay along a silk thread which ran along in the axis of the three stones. Two others were also bound together by a silk thread. The last two small ones were free. The threads arose from the sutures of the gall-bladder to the abdominal wall.

CASE IV (ENDERLEN, reported by Flörcken<sup>19</sup>).—Thread remains after cholecystostomy. About five years previous had been operated on by Courvoisier. Recurrence of colics and again operated. Button-like stones were found running along a thread in the gall-bladder, also some free stones.

CASE V (KEHR<sup>20</sup>).—Formation on thread of gauze after cholecystectomy with tamponing of hepatic duct on account of tearing. Woman, age forty-one. Operated on February 5, 1900. Cholecystectomy. Hepatic duct torn slightly and tamponed. Later had attacks without icterus.

October, 1900: Resistance in region of the scar. Temperature, 38.8°, no icterus. Diagnosis: Overlooked stone in cystic duct (probably from the gall-bladder). Abscess on under side of liver, left over piece of gauze.

Second operation October 23, 1900. By careful palpation of cystic duct



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could be felt a round body, but which slipped under the fingers. Cystic duct opened and a sound passed liverwards and duodenalwards with no stones palpable. Increased the length of cut. The insertion of the little finger felt in the depths a soft stone which was extracted. Hepatic and cystic duct drainage. By closer examination of the stone it showed that it enclosed a piece of gauze. On breaking there were found two 3 cm. long gauze fibres. The stone was very soft so that with the sound it could not be demonstrated. Following this concretion, which evidently lay in the cystic duct, were still others and, last, one of the size of a hazel-nut.

CASE VI (RITTER<sup>21</sup>).—Thread remains after gall-stone operation. A young woman for some months after the operation felt discomfort and at the end of the year, after a severe attack, a stone as large as a bean was passed. Through the middle of this concretion a short silk thread passed, which thread had been used as a ligature at the time of the first operation.

CASE VII (HANSEMAN<sup>22</sup>).—The following case stands wholly isolated, insomuch as it is not an example of stone formation in the gall-bladder or gall-passages but of gall-stone formation on a thread in the duodenum without recurrence in the gall tract itself.

Woman, age forty-eight. Operated on January 17, 1895. Gastrotomy, gastro-enterostomy and partial resection of the bowel because of an advanced cancer of the pylorus. At autopsy, August, 1895, showed in the duodenum a silk thread on which were found two stones, the greater of which was about 12 mm. long and 5 mm. thick; the smaller 5 mm. long and 3 mm. thick. The stones were of gray-brown color, somewhat of the firm consistency of shell. Chemically they were formed from pigment and cholesterin, so they appeared to be real gall-stones, not fecal concretions. In the gall-bladder there were no stones.

CASE VIII (FLÖRCKEN<sup>23</sup>).—Woman, age twenty-seven. Operated on October 30, 1903. Cholelithiasis with acute empyema of the gall-bladder. Many faceted stones removed. Cholecystostomy. Uneventful recovery. In January, 1906, again had gall-stone colic and passed two stones per stool. In January, 1908, again reported with gall-stone pains.

Second operation January 27, 1908. Distended, adherent gall-bladder containing two free stones (possibly overlooked at the first operation), also three stones fixed to the gall-bladder wall, each with a silk thread as its nucleus. One of these stones was ring-shaped, owing to the shape of the loop of silk composing its core.

CASE IX.—DAVIS<sup>24</sup> reports a case not his at the primary operation but sent to him a year after her first operation complaining of even more severe symptoms than before her first operation. He found three chromic catgut sutures in her gall-bladder, they apparently having been used as purse-string sutures. Each one was studded with stones like beads.

*Miscellaneous and Doubtful Cases.*—CASE I (KORTE<sup>25</sup>).—Operated on August 24, 1891. Solitary stone in cystic duct, size of a pigeon's egg, oval, non-faceted. Gall-ducts themselves free. Cystotomy with iodoform gauze packing. Seven years later recurrence of colic with icterus. This patient did not return for observation and the sole evidence of a true recurrence is based on the long interval before the recurrence of symptoms.

CASE II (KORTE<sup>26</sup>).—Operated on March 9, 1894, for an acute empyema of the gall-bladder. Four stones removed. Cystostomy. Recurrence of colic



January, 1900. Passed two gall-stones without foreign body nuclei, after which there was no further trouble.

The six-year free interval in this case is the sole proof of recurrence.

CASE III (KORTE<sup>27</sup>).—Operated upon April 28, 1893. Acute cholecystitis with threatened perforation. Cystostomy. 2550 small stones removed. In 1904, eleven years after the first operation, had her first return of colic. In November, 1904, Korte thought that he could feel a contracted stone-containing gall-bladder but the patient refused the proposed cholecystectomy.

CASE IV.—FLÖRCKEN<sup>28</sup> reports a case of gall-bladder regeneration with stone formation after cholecystectomy. This case had had a cholecystotomy for empyema of the gall-bladder in September, 1908, followed by recurrence and cholecystectomy in December, 1908. Symptoms recurred again in six weeks and about twenty-five months later (February, 1911) a gall-bladder 3.5 cm. long and 2.5 cm. wide was found with a free cystic duct and containing a stone which Flörcken took to be new formed. The fact that symptoms recurred within six weeks after the first cholecystectomy makes it seem probable that this is really a case of overlooked stone in an incompletely resected gall-bladder instead of a true recurrence.

CASE V (JAMES AND SHERMAN<sup>29</sup>).—Female, age thirty-four. A ten-year history of cholecystitis with acute exacerbations. Operation December 30, 1910. Cholecystostomy. No stones found in gall-bladder or ducts. Ducts patent. Fistulæ closed in 16 days. Recurrence of pains 43 days after closure of fistulæ. Spontaneous opening of fistulæ two days later with free drainage of non-icteric, mucopurulent fluid. Continuous mucus discharge of from 25–200 c.c. of fluid daily until November 13, 1911, when she was reoperated. Cholecystectomy. A calculus 2 cm. in diameter found impacted in cystic duct with complete occlusion of duct proximal to stone. The stone was found to be a cholesterol calculus, bile free except for a pin-head sized, brownish nucleus. The authors report this as an example of a stone forming in the gall-bladder or cystic duct after the first operation, yet if this stone was itself the cause of the blockage of the cystic duct, it must either have been overlooked at the time of the first operation or it must have formed within 43 days after the cessation of drainage. On the other hand, if it was not the primary cause of the cystic duct obstruction it is hard to account for it having become impacted in the cystic duct during a period when there could have been no pressure behind it owing to the external fistula.

CASES VI, VII and VIII.—Three cases of late recurrence of clinical symptoms classified by me in a previous paper (*loc. cit.*) as probable instances of reformation of stones but as yet, as far as I know, none of these cases have undergone a second operation.

SUMMARY AND CONCLUSIONS.—If no foreign body is left in the gall-bladder or ducts after the operation, the reformation of gall-stones is so rarely observed as to constitute almost a negligible factor in gall-bladder surgery.

The reported cases do not bear out the assumption that cholecystectomy affords a much greater immunity against reformation of calculi than does cholecystostomy.

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Adequate care should be exercised not to leave threads from gauze sponges nor unabsorbable suture material in the gall-bladder or ducts at the close of the operation.

The data consulted during the preparation of this paper has further strengthened me in the belief that the two most important factors in determining the end results of gall-bladder surgery are the *complete* removal of the calculi and the maintaining of sufficiently prolonged post-operative drainage. In the absence of organic duct strictures I believe that the question of cholecystostomy *vs.* cholecystectomy is largely one of technical expediency in individual cases. In many badly diseased gall-bladders it is easier and safer to remove the gall-bladder than to try to remove all of the stones and fragments of stones from the gall-bladder *in situ*, and the same is often true of gall-bladders containing great numbers of minute stones and cholesterine particles.

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## DOUBLE INTERNAL JUGULAR VEIN—HIGH BIFURCATION OF COMMON CAROTID ARTERY

BY JOHN W. CHURCHMAN, M.D.

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I HAVE recently met, during the dissection of the neck, two anatomical variations in the large vessels which seem to be of sufficient importance to record.

*Double Internal Jugular Vein.*—The first anomaly was encountered during the removal of tuberculous glands from the upper part of anterior cervical triangle on the right side. The operation was done through a transverse incision parallel to the lower jaw and about  $1\frac{1}{2}$  inches below it. A large tuberculous gland, tightly adherent to the platysma muscle, was encountered and dissected free from this structure with some difficulty. The internal jugular vein was then exposed in its usual position (see Fig. 1, *B*), and the gland found to be very closely adherent to it. It was gradually freed, however, without injury to the vein. A dissection of the lower portion of the gland was then begun and I was surprised to find at the site indicated in the drawing (see Fig. 1, *C*) another vein, larger than the first, roughly parallel with it, and about 1 inch distant from it,<sup>1</sup> running behind the gland, to which it was adherent. This vein was freed from the gland without much difficulty, and the glands then removed in the usual way without incident. The first vein encountered ran in the usual situation, immediately adjacent to the carotid artery. Through the transverse incision used in this operation the origin and termination of the second vein could not be determined. Its position is well shown in the drawing (see Fig. 1, *C*). It responded very markedly to the respiratory movements of the patient, and when ballooned by expiration was about one-third again as large as the vein first met.

This anomaly must be sufficiently rare; at least I have not encountered it in a large number of neck dissections. Some of the anatomical text-books make rather vague reference to the occasional occurrence of a double vein; and Columbus (1590), quoted in Theile's treatise on

<sup>1</sup> The artist has represented these two veins rather closer together than they actually were.

the muscles and blood-vessels, reports having seen this anomaly. The possibility of a second internal jugular vein is perhaps worth bearing in mind, particularly in adherent gland cases; for after the glands have been freed from the vein, one, proceeding rapidly and with the usual sense of relief, might injure a second vein if one were not prepared to meet it.

*High Division of the Common Carotid Artery.*—The second anomaly, of much more frequent occurrence, I happen never to have observed before. In this patient a dissection of the glands in the upper part of the neck was being done as a preliminary to excision of the jaw for giant-celled sarcoma. After the glands had been removed, I proceeded to ligation of the external carotid artery. On exposing the usual point of division of the common carotid, no such division was found nor could any branch representing the external carotid be located by following the vessel down below the level of the lower border of the thyroid cartilage. On following the vessel up, however, the bifurcation was found under the posterior belly of the digastric muscle, but could only be seen on retracting this structure upward. There were no branches seen coming from the part of the common carotid exposed below the bifurcation. I did not make a note of the superior thyroid artery but my impression is that it arose from the external carotid just beyond the point of division. Of course, with the neck well exposed as in this particular operation, this anatomical variation was of very little importance, causing slight delay but no particular embarrassment. If, however, one had been attempting to ligate the external carotid through a small incision, one would have been considerably embarrassed by this unusually high point of division, which is well shown in the accompanying illustration (see Fig. 2).



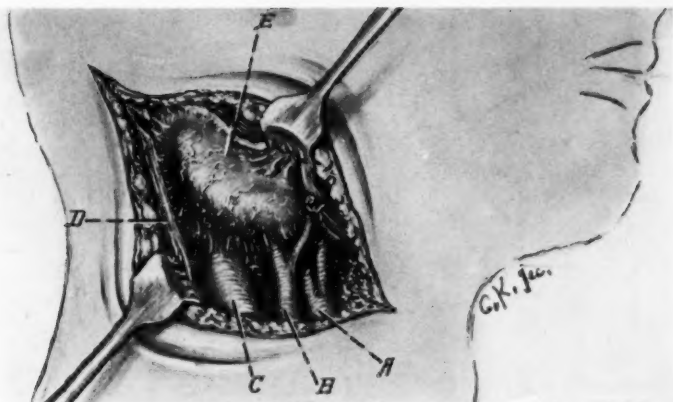


FIG. 1.—Double internal jugular vein. *A*, common carotid artery; *B*, internal jugular vein; *C*, second internal jugular vein; *D*, retracted sternocleidomastoid; *E*, tuberculous gland.

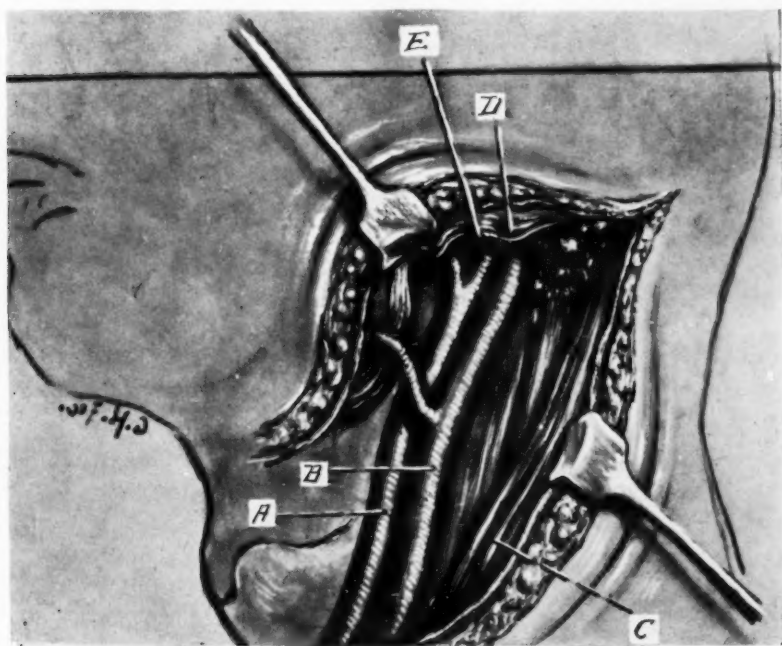


FIG. 2.—High bifurcation of common carotid artery. *A*, common carotid artery; *B*, internal jugular vein; *C*, sternocleidomastoid retracted; *D*, digastric muscle; *E*, bifurcation of common carotid artery.



TRANSACTIONS  
OF THE  
PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting, Monday evening, October 5, 1914*

The President, DR. JOHN H. GIBBON, in the Chair

MOWING MACHINE CUT OF LEGS

DR. EDWARD B. HODGE presented a boy of three and a half years whose right leg had been nearly severed by the blade of a mowing machine. Both bones and the anterior tibial vessels and nerve, with the extensor muscles, were entirely divided. There was some laceration of the calf muscles next to the bones, but the posterior tibial vessels were not injured. Circulation in the foot was good. Under iodine sterilization the anterior tibial vessels were tied, the nerve sutured, and the ends of the divided muscles united as accurately as possible without unduly enlarging the incision and prolonging the operation. The child had lost much blood. The wound was dressed in a fracture box without drainage. Healing took place with slight discharge of serum, but no infection, and the boy has a perfectly useful leg. There is slight toe-drop and later it is probable that some further work will be needed on the muscles. There is a slight amount of sensation on the dorsum of the foot.

SARCOMA OF TONSIL

DR. GINSBURG presented a man who had developed a growth in the right tonsil, the condition dating back to April of the present year. He had operated upon it in two stages; in the first operation, he removed the anterior palatine arch and the tonsil. Three weeks later, he made a dissection of the neck, removing the right submaxillary salivary gland, and all visible lymphoid tissue, finally ligating the external carotid artery at the bifurcation of the common carotid. A rapid recurrence has followed, and at present he is receiving daily treatments with radium, holding the tube containing the radium in his mouth for five hours at each sitting. Thus far he has received six radium treatments, and there is evidence of beginning resolution of the pathological overgrowth. The diagnosis is sarcoma of the right tonsil.

PHILADELPHIA ACADEMY OF SURGERY

AN ANALYSIS OF TWO HUNDRED AND TWENTY-SIX CASES OF  
ACUTE INTESTINAL OBSTRUCTION

DR. GEORGE G. ROSS read a paper with the above title, for which see page 198.

DR. CHARLES H. FRAZIER said that one of the most important life-saving factors in the management of cases of intestinal obstruction is the avoidance of a general anæsthetic, particularly ether. These patients are intensely toxic and do not stand an anæsthetic well. The greater part of the operation can almost always be conducted under a local anæsthetic, and at most a few whiffs of nitrous oxide may be required to allay pain.

DR. JOHN H. GIBBON said that there are two elements in the mortality of strangulated hernia or intestinal obstruction: One is the anæsthetic, already mentioned by the authors and in discussion. General anæsthesia should be avoided whenever possible, in the hernia cases especially. If a general anæsthetic is used, it should be as short a period of general anæsthesia as possible. Not only because of the bad effect of the anæsthetic upon the patient, but because the man who is operating under a general anæsthetic is tempted to do a great deal more than if operating with a local anæsthetic. It is trying to complete an operation that often results in the death of these patients. This is particularly true in regard to colonic obstruction. When the patient is anæsthetized it is easy to make the mistake of trying to do too much instead of simply trying to relieve the obstruction, and doing the radical operation at a later stage.

Another point is that of post-operative obstruction—a condition the frequency of which has greatly diminished in recent years. This difference is due to the fact that we are not packing abdomens full of gauze, and that drains are covered with rubber to prevent adhesions.

DR. ROSS, in closing, said that the technic carried out is a very simple one. As a rule, a general anæsthetic is used; infrequently, a local anæsthetic. The anæsthetic is given to the degree that obstetricians give it, enough to dull the patient's sensibilities. The abdomen is rapidly opened with a liberal incision and evisceration done at once. No attempt is made to locate the obstruction. The entire small bowel is delivered and laid upon a wet towel. At once the obstruction comes into view and it is dealt with according to the condition of the bowel and condition of the patient. If the patient is profoundly toxic, enterostomy is done and the wound sewed up. If the patient's condition warrants it, resection is attempted when the bowel is badly damaged, but as a rule the intestines are put back at once, salt solution used, drainage instituted,

#### TRAUMATIC RUPTURE OF THE DEEP URETHRA

and the wound sewed up. Paul's tubes we rarely use to drain the bowel. Occasionally, but rarely, the bowel is fastened to the anterior abdominal wall for the purpose of permanent drainage.

Post-operative adhesions are diminishing in frequency. It used to be, five, six or seven years ago, that one patient out of eleven coming to the German Hospital with appendiceal abscess and drained with the method employed at that time, of large folds of iodoform gauze, had post-operative obstruction. This is not so to-day, because a different method is used. Rubber tissue is used to protect the capillary drains and prevents adhesions.

#### TRAUMATIC RUPTURE OF THE DEEP URETHRA

DR. GEORGE G. ROSS presented a boy, aged eleven, who was run over by a heavy wagon, the wheels passing diagonally over the right lower abdomen, pelvis and left hip, at 7.30 P.M., April 21, 1914.

On admission the boy was shocked and in great pain; temperature remained subnormal until the following morning. Pulse was weak and thready and rose to 144 by the following noon. Examination revealed a bruised abdomen and hip, and in addition a fracture of the left tibia in the upper third. The patient's chief complaint was rectal pain. No urine was voided from 7.30 P.M. until the following day. Shortly before noon the day after the accident the patient was catheterized. Before this had been done some blood was noted at the meatus. The first use of the catheter brought a few drops of blood and later one-half ounce of bloody urine. There was great abdominal and perineal tenderness and swelling in the perineum. At 2.15 P.M., on April 22, hypodermoclysis was given and strychnine ordered. Dr. Ross saw the patient at 4 P.M. and concluded that operation was inadvisable because of the patient's general condition.

In the next few days the abdominal rigidity lessened and catheterization was possible. A retention catheter could not be employed because of the discomfort caused. The patient's general condition improved, the pulse, however, remaining very weak and there being always much abdominal pain and tenderness. An X-ray showed a fracture of the descending ramus of the left pubic bone. The patient began to void urine fairly well four or five days after the accident, often involuntarily, and had involuntary bowel movements.

On April 27, the sixth day, he became very restless and began to run a septic temperature. Examination revealed a lower abdominal resistance with tenderness suggesting urinary extravasation, and operation was decided upon. On April 28, 1914, one week after the accident, a



suprapubic incision was made and the space of Retzius opened. A large quantity of ammoniacal urine was evacuated. The broken portion of the pubis could be easily felt, but evidently had sprung back partly into place. A catheter (silver) introduced showed its tip through a rent in the bladder just at the site of the urethral junction—or the site of the urethral avulsion—and could not be introduced into the bladder proper. Drainage tubes were introduced and allowed to remain a number of days. The temperature was septic for a week, and mildly febrile for a week, and then from the third to sixth week septic, but not severely so. All urine came through the suprapubic wound. Several attempts at catheterization were failures. On May 27 a deep gluteal abscess was opened by his assistant, Dr. Mencke. It was a hard abscess with little pus that had been extremely painful and evidently caused by deeply burrowing urine. The suprapubic wound showed great tendency to close and the discharge of urine was impeded. This gave the patient great pain. The incision was again enlarged on May 27, but an attempt to pass the catheter was unsuccessful.

Finally, these closures exhausted the patient so much that on June 9 under ether anæsthesia he attempted catheterization, and was successful in introducing first a silver catheter and then a 10 English woven catheter, which was sewn in and remained five days. The suprapubic incision was cleaned of old granulations. The former bladder rent was not felt. The catheter remained in five days and since then the patient voids naturally. No urine has come out above since the last operation.

DR. GWILYM G. DAVIS said that, in cases of rupture of the urethra in the membranous portion or in close connection with the bladder, difficulty is often experienced, as in this case, of passing the catheter into the bladder. Some years ago he was visiting in the country and he was asked to see a man who had sustained a rupture of the urethra from falling astride a board. There was no external wound at all, and the endeavor to introduce a catheter by the usual method was a failure. He therefore injected warm water into the urethra through the meatus, which distended the urethra and also the parts at the site of the injury. He then took up a large metallic catheter and with ease passed it across the broken part into the bladder. He suggested the method as worthy of trial in such cases.

TRANSACTIONS  
OF THE  
NEW YORK SURGICAL SOCIETY

*Stated Meeting, held at the New York Academy of Medicine, November  
11, 1914*

The President, DR. FREDERIC KAMMERER, in the Chair

ECHINOCOCCUS CYST OF THE LIVER

DR. A. V. MOSCHCOWITZ presented a married woman, forty years old, of Russian birth, who on March 19, 1914, was admitted to the medical service of the Har Moriah Hospital, in the care of Dr. S. Neuhof.

Her chief symptoms were entirely referable to the urinary system; namely, pain in the region of the right kidney and anuria of four days' duration, followed by frequent but scanty urination.

In the region of the right kidney palpation definitely located a globular mass the size of a large cocoanut; this was painful and tender on pressure and moved slightly with respiration. The quantity of urine voided on different days varied from 880 to 1360 c.c.; its specific gravity ranged from 1010 to 1015; it was negative for albumin, sugar, bile, casts and cells; there was an ample excretion of urea.

The patient was operated on for a supposed hydronephrosis, on April 6, 1914. Through an incision parallel to the last rib a normal kidney was exposed, and the large mass, it was then made out, was located within the peritoneum and connected with the liver. The peritoneum was thereupon incised, and, no adhesions being present, a small portion of the tumor was isolated by packing, and upon aspiration a perfectly clear, limpid fluid was obtained. The fluid was under such tension that immediately upon withdrawal of the fine needle, echinococcus daughter cysts popped out. The capsule was thereupon incised and its contents evacuated, and as the condition of the patient warranted it, the mother cyst was enucleated from the parenchyma of the liver. The hemorrhage, which was rather profuse, was readily controlled by packing, and in order to secure a firm basis for the packing the liver was fixed in the wound by sutures.

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Tube and gauze drainage was inserted and the external incision partially closed.

Subsequent to the operation, the wound in the liver discharged bile rather freely. The tubes and packing were gradually shortened and the wound finally closed, the patient being discharged in a little over five weeks. At no time was there any anaphylactic reaction.

Dr. Moschcowitz said he had no apologies to offer for the erroneous diagnosis in this case; he was led into it by the history, the symptoms and physical signs, all of which pointed to an involvement of the kidney, and by the absence of all those physical and clinical signs that one would be led to expect to find in echinococcus disease of the liver.

DR. JAMES I. RUSSELL recalled a case of echinococcus cyst of the liver in which the symptoms, with the exception of a slightly higher eosinophilia, were practically identical to those in the case shown by Dr. Moschcowitz and led to a similar error in diagnosis. The symptoms, as in this case, were ascribed to a probable hypernephroma, and after exposing a normal kidney the tumor was found underneath the peritoneum and proved to be a pedunculated echinococcus cyst of the liver which was extirpated *in toto*.

## GALL-STONE ILEUS

DR. MOSCHCOWITZ presented a married woman, fifty-eight years old, who was successfully operated on by him on May 18, 1913, for a large, irreducible umbilical hernia by the Blake method. She was readmitted to the Mt. Sinai Hospital on May 11, 1914, when the following history was obtained: There had existed an absolute constipation for the past four days, accompanied by increasing abdominal distention and incessant vomiting, which had become fecal in character during the past twelve hours. The patient was markedly prostrated, with a rapid pulse, but no fever. The entire abdomen was enormously distended and very painful and tender, but there was nothing localizable and no recurrence of the hernia. The diagnosis of intestinal obstruction of unknown origin was made. Gall-stone ileus appeared to be the least likely, as there was nothing in the history that was referable even remotely to the liver or bile tract.

An immediate operation was done. The old cicatrix was first excised and no recurrence found. Numerous distended loops of small intestine were encountered, and the entire colon was collapsed. Palpation revealed, as a cause of the obstruction, a stone, the size of a walnut,

## GALL-STONE ILEUS

impacted low down in the ileum. The intestine was firmly contracted upon the stone, so that no amount of warranted manipulation could dislodge it upward into the dilated portion of the intestine. He was therefore compelled to cut down upon the stone at the contracted part. Upon removal it was found to have one large facet, but it was uncertain whether this facet was directed upward or downward. The intestinal incision was closed in two layers, but this narrowed the lumen to such an extent that it was deemed advisable to add an entero-enterostomy between the proximal and distal loops. A hasty palpation of the gall-bladder and the rest of the intestines failed to reveal the presence of the expected companion stone.

During the various manipulations there were noted literally hundreds of indurated areas, covered with fibrin, in the mesentery, near its attachment to the small intestine. The larger ones were fully the size of a marrow-fat pea: these were wiped out with tincture of iodine, and a culture subsequently showed the bacillus coli communis to be the infecting agent. The speaker said he accounted for these small abscesses by assuming traumata and ulcerations of the intestinal mucosa caused by the migration of the stone, with subsequent infection and transmigration of the bacillus coli into the mesentery.

The closure of the wound proved difficult and incomplete, and it was drained by a tube and rubber dam. The prognosis was apparently very bad and Dr. Moschowitz said he was agreeably surprised when he found a few hours later that the patient had reacted well from the operation and was in a fair condition. On account of the presence of the numerous abscesses in the mesentery which had been practically left untreated, he still regarded the outcome of the case as unfavorable. For some time after the operation the wound discharged very freely, the pus having an offensive odor. On June 5 the patient complained of pain in the rectum, and examination revealed the presence of the long searched for companion stone. The discharge from the wound gradually diminished and the patient was discharged, well, on June 13.

DR. WILLIAM A. DOWNES recalled a case of gall-stone ileus about three years ago, shown by him before this Society, which came under his care at St. Francis Hospital, in the service of Dr. Kammerer. In that case, about forty-eight hours after the original operation, at which one gall-stone was found and removed, the symptoms of intestinal obstruction recurred, and upon reopening the wound, a second stone was found impacted in the gut at the point where the sutures had been in-



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sented. Such cases, Dr. Downes said, if the patient's condition would permit, showed the wisdom of making a thorough search when we were dealing with a faceted stone.

### SPASTIC PARAPLEGIA DUE TO ABNORMALITY OF THE POSTERIOR SPINAL VESSELS

DR. CHARLES A. ELSBERG presented a Turk, twenty-three years old, who was admitted to the Neurological Service of Mount Sinai Hospital on the service of Dr. B. Sachs, in October, 1914. The patient complained of cramp-like pains in the right side of the abdomen, running down the right lower extremity, of three months' duration. With this there had occurred symptoms of increasing loss of power and spasticity in the lower extremities.

Physical examination showed that the abnormal reflexes were absent on the right side. The knee-jerks were exaggerated, the left greater than the right. There was no clonus nor Babinski. The left leg was weaker than the right. There was a slight tenderness of the spinous processes of the ninth dorsal segment. The Wassermann test and X-ray were negative. The symptoms gradually grew worse, so that one week later he had slight Babinski on the left side, with exhaustible ankle clonus and spasticity of the left lower extremity. The sensory signs consisted of almost complete loss of pain, temperature and touch of the right lower extremity up to the level of the tenth dorsal segment. The symptoms therefore pointed to a focal lesion, surely extramedullary, probably in the anterolateral region at the ninth to the tenth dorsal segments.

Laminectomy was performed by Dr. Elsberg on October 16, 1914. The spinous processes and laminæ of the seventh, eighth and ninth dorsal vertebræ were removed in the usual manner. When the dura was opened there was an escape of a large amount of cerebrospinal fluid. The surfaces of the cord were found normal. The fifth and sixth dorsal spines and laminæ were then removed, and the dura incised in an upward direction. It was then seen that the right posterior spinal vein ran a normal course, while the left was much enlarged, and ran, together with the sixth left posterior root, through the opening in the dura. The vein was almost again as large as the nerve root. The vessel was tied off at the dural opening and about two centimetres of it excised. The wound was closed in the usual manner.

Convalescence from the operation was uncomplicated. The patient was out of bed in two and a half weeks; the symptoms improved rapidly,



#### EXTRAMEDULLARY SPINAL TUMOR

and by November 2, all of the sensory and most of the motor symptoms had disappeared. He was free from pain and seemed to be cured.

Dr. Elsberg mentioned that this was the second instance of an abnormality of the posterior spinal vessels of this kind that he had operated upon. The first patient presented very similar symptoms and was completely and permanently relieved by the excision of the enlarged and abnormally located blood-vessel. This was a condition which had not been described in the literature, *i.e.*, that an abnormal vessel could cause a spastic paraplegia with level symptoms, and that complete relief could be gained by operation.

These two cases, Dr. Elsberg said, would be reported in detail in another place.

#### EXTRAMEDULLARY SPINAL TUMOR

DR. ELSBERG presented a man, twenty-four years old, who was admitted to the New York Neurological Institute in January, 1912, with a history of one year's standing. He first noticed a tickling sensation in the calf of the right leg, gradually extending upward. This persisted for ten months, when he noticed that when taking a bath the upper part of his body was more sensitive than the lower. Nine months before, the right knee became stiff and he had difficulty in walking. Four months ago the left leg became similarly affected, and since that time he had grown gradually worse.

At the time of his admission there was a marked spastic paraplegia of the lower extremities, with sensory symptoms of all three sensations to the left of the tenth dorsal segment. The Wassermann and X-ray were negative. Patient refused operation and left the hospital. He returned on the first of July in a much worse condition. He was bed-ridden, and there was complete paralysis of the lower extremities, with marked bladder and rectal disturbance.

The physical examination showed spastic paraplegia of both lower extremities, with exaggerated reflexes, ankle clonus, Babinski and Oppenheim. The sensory symptoms consisted of diminution of all three sensations up to the tenth dorsal level on the right side, and a total loss of feeling to the same level on the left.

Laminectomy was performed on July 5, 1912, the spines and laminae of the five lower dorsal vertebrae being removed. Nothing was found to explain the symptoms. The patient went home after two weeks, unrelieved.

He was next seen at Montefiore Home in January, 1914. At this

## NEW YORK SURGICAL SOCIETY

time there were symptoms, both sensory and motor, up to the level of the second dorsal segment with no sensory disturbances in the upper extremities; therefore, this part of the cord was exposed by laminectomy on January 6, the seventh and eighth cervical and first and second dorsal spines being removed. Nothing was found over the region of the exposed spinal cord. A probe passed upward, however, met with a resistance at the level of the sixth cervical; therefore three more spines and laminae were removed in an upward direction, and at the upper area of cord exposed, far above where the symptoms had indicated, a small extramedullary tumor was found and easily removed.

Convalescence from the operation was uncomplicated. Improvement began at once, and at the present time the patient was practically entirely well; he was able to walk long distances without trouble, and all of the motor and sensory symptoms had disappeared.

The interest in this case lay in the shifting of the level symptoms. In July, 1912, the symptoms pointed clearly to the tenth dorsal segment; in January, 1914, the symptoms pointed to the second dorsal segment, but the tumor was found at the sixth cervical segment.

## APERIOSTEAL AMPUTATION THROUGH THE FEMUR

DR. H. H. M. LYLE presented a young man who, while speeding on a motor cycle, collided with an automobile. He sustained a severe, compound, comminuted fracture of the ankle-joint, with extensive laceration of the soft parts. On arrival at St. Luke's Hospital on August 29, 1914, the wound was immediately explored, the ground-in dirty straw and clothing removed, drainage provided, and a prophylactic dose of tetanus antitoxin administered. On the following day his temperature rose to 106°, and the wound showed unmistakable evidence of gas bacillus infection. The rapid spread of the emphysematous gangrene necessitated the removal of the leg at the knee-joint, a Stephen Smith disarticulation being done.

Although the procedure served to check the spread of the gangrene, the wound broke down and the flaps retracted to such an extent that an aperiosteal amputation through the junction of the lower and middle thirds of the femur was done by Dr. Frank S. Mathews. As soon as the wound healed, Hirsch's medico-mechanical exercises were begun, and fourteen days later the patient could bear all his weight directly on the end of the stump, and at present he could walk comfortably on the home-made peg-leg (Figs. 1-4).

Dr. Lyle said his object in presenting this case was to emphasize the



FIG. 1.—Patient bracing his weight on the stump 14 days after the healing of the wound.



FIG. 2.—Patient exercising with peg-leg.



FIG. 3.—Patient exercising with peg-leg.



FIG. 4.—Patient wearing a home-made peg-leg. Patient was able to walk on this leg 14 days after the healing of the wound.



## APERIOSTEAL AMPUTATION THROUGH FEMUR

value of the systematic post-operative treatment of the stump, and to prove that it was possible in amputations through the shaft of the femur to produce a painless end-bearing stump. He conceded that the osteoplastic method was the ideal one under ideal conditions, while the tendinoplastic was of limited value. The periosteal, although employed by the majority of the surgeons in this country, was inferior to the other methods; while the aperiosteal, in the advent of complications in healing, was the only method which was likely to furnish a useful end-bearing stump. It was the simplest, the most universally applicable and the most practicable.

In reply to an inquiry as to the technic employed, Dr. Lyle said he removed the periosteum for a distance of one centimetre above the saw-line, and spooned out the medullary canal for a similar distance. The stump was treated as follows: As soon as the wound had healed, the stump was massaged twice daily and after each treatment a two per cent. solution of salicylic acid in olive oil was rubbed in. At night the parts were bathed in a warm sodium carbonate solution and the stump protected with lamb's wool. A box was placed at the foot of the bed and the patient instructed to press the stump against it for from five to ten minutes, at first three times a day, then four times, and finally every hour, and after each treatment the hip was energetically flexed and extended. After this the standing exercises were begun, the patient resting the stump on a bran bag, at first placing the weight evenly on both legs and later resting all his weight on the stump. At the end of two weeks the patient should be able to wear a peg-leg and later a permanent prosthetic appliance which directly receives the weight through the end of the stump.

DR. ROBERT H. M. DAWBARN said that when we resorted to a Stephen Smith disarticulation in a case where there was ulceration at any point on the limb below the flaps, we were practically certain that suppuration would follow. In such cases he removed the patella as a matter of course, because even though its lateral attachments were well divided, it so pressed down upon a drainage tube passing beneath, up into the synovial sac above, as to interfere with drainage and seriously prolong a suppurative case.

Speaking of amputations through the thigh, Dr. Dawbarn said he wished to congratulate Dr. Lyle and Dr. Mathews upon the very satisfactory outcome of this case. At the same time, it violated the dictum of Bier that in order to make a comfortable, end-bearing stump, we must have articular cartilage or undisturbed periosteum. If we get



aseptic healing, we can sometimes expect a comfortable, end-bearing stump just the same, without these coverings to the bone.

In order to avoid the contraction of certain muscles of the thigh that follows the division of all at the same level, and thus to prevent objectionable "dead spaces," the speaker said the hamstring tendons should be divided as a preliminary measure. This would permit the muscles that extended from the pelvis to the leg, gliding over the femur in their course without attachment to it save part of one hamstring, to retract; and they would then, upon amputation, all have about the same level as that of the remaining muscles of the thigh which could not retract far when cut because of their long attachment to the femur. This point in technic was performed even before cording the thigh by two bold strokes, each of which divided the hamstring or hamstrings of its own side, an assistant at once thrusting his thumb into the wound, thus preventing bleeding. Then the cording was done and amputation followed.

Hamstring against dead spaces was credited to Dr. Dawbarn, he added, in the works on surgery of Fowler, Brewer and others, and should be better known than it is.

DR. LYLE, in closing, said the original dictum of Bier which was referred to by Dr. Dawbarn was no longer adhered to by Bier himself. While the Bier method was the ideal one, the aperiosteal was preferable in those cases where suppuration had occurred and the former could not be used.

As to the length of time of after-treatment required by this method, the speaker said that depended on the length of time the wound took to heal. After the patient could once walk on the stump, the exercises could be abandoned.

#### PRESERVATION OF THE ILIOHYPOGASTRIC NERVE IN OPERATION FOR THE CURE OF INGUINAL HERNIA

DR. CHARLES N. DOWD read a paper with this title, for which see page 204.

DR. ALFRED S. TAYLOR said that instead of being cut, this nerve was occasionally caught in the sutures and gave rise to trouble in that way. He recalled such a case which was operated on by Dr. Robert F. Weir. The patient complained of considerable pain and tenderness about the wound, and when the latter was opened, a deep infection being suspected, they found instead that the iliohypogastric nerve had been caught

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in one of the sutures, which by compression had given rise to a neuritis. Since his observation of that case, Dr. Taylor said, it had always been his practice to elevate the nerve and in that way avoid its inclusion in the suture.

DR. ARTHUR S. VOSBURGH said that in order to interfere with the innervation of these muscles, the cutting of the nerves had to be done at a point above the internal ring, where they gave up their motor filaments to these muscles, as the parts of the nerves that appeared in the field of operation were purely sensory and were distributed to the skin and subcutaneous tissues. A neuritis or neuralgia might easily be set up by pinching the nerve in one of the sutures if too tightly drawn, as suggested by Dr. Taylor.

In connection with recurrent hernia, as mentioned by Dr. Dowd, the great majority were found to be direct. This preponderance of direct hernia in the recurrences Dr. Vosburgh thought could be explained by the fact that many small direct or potential herniæ were not recognized at the time of the first operation. The oblique hernia would be cured, but the beginning direct hernia would manifest itself as a recurrence. A direct hernia occurring through the outer portion of Hesselbach's triangle would simulate closely an oblique inguinal hernia. If the Bassini method was followed in such a case, the result was almost sure to be a recurrence. Personally, it was his practice to see that the neck of the sac was external to the deep epigastric artery, and only in those cases was the Bassini method followed. In direct hernia he invariably did a transplantation of the rectus. He recalled a case of direct hernia where the musculature seemed so good that he was led to try the Bassini method. The operation was followed by a prompt recurrence, and when the patient returned to him, he did a transplantation of the rectus, and the man had up until the present time remained free from a further recurrence.

Dr. Vosburgh said that in recent years he had observed a great many more cases of direct hernia than in the past. Whether this was merely a coincidence or whether he had become more successful in recognizing the condition he was unable to say: at all events, he was convinced that a direct hernia should always be treated by a method other than the Bassini.

DR. FRANK S. MATHEWS said that in two or three cases coming under his observation where an appendix operation was done through a fairly low incision, the operation was followed by an ordinary right inguinal hernia. He had had reason to think that the herniæ were due

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to nerve injury, as the incisions had not been low enough to divide the muscle fibres supporting the ring.

DR. DAWBARN said he thought there was no doubt about the accuracy of the observation made by Dr. Mathews. If we did the muscle-splitting operation for the removal of the appendix, we were much less likely to divide the iliohypogastric or ilioinguinal nerves, with consequent risk of inducing inguinal hernia, than by a single incision down one line into the belly.

Dr. Dawbarn said that Bassini's recent figures were not very favorable as to the occurrence of relapses after his method of operation, when compared to the best percentages; and one reason for this probably was that he made no mention of the necessity of so dissecting, both superficially and beneath, as to free the conjoined tendon so that it would drop down to Poupart's almost of its own weight, and not be dragged unwillingly down by the stitches. Another unfavorable point was that Bassini allowed his patients to get up and leave the hospital on the eighth day, which the speaker thought was too early for the strain of the upright posture.

When this subject came up for discussion at a meeting of this Society a few years ago, Dr. Arpad G. Gerster brought out a very valuable point as to a probable etiological factor in the recurrence of hernia, namely, that many of these operations were done on hospital patients whose general condition was often below par, from disease or dissipation or both, and where we had to operate, so to speak, upon shoddy cloth, as contrasted with the wearing qualities of sound clothing of good quality; and naturally, the shoddy material easily gave way again upon subsequent strain.

DR. MOSCHCOWITZ said he agreed with Dr. Taylor that the inclusion of these nerves in the suture should be avoided, as such a pinching of the nerve might give rise to a subsequent neuralgia.

As to the cause of recurrences after operations for inguinal hernia, Dr. Dowd emphasized two points, *i.e.*, adequate suture and the preservation of the nerve supply. To these, the speaker said, he would add high ligation of the sac. In considering an operation for the radical cure of inguinal hernia we should have in mind not only the condition of the patient immediately after the operation or while he was still on the operating table, when every case was a radical cure, for the time being at least, but the condition of that patient six months afterwards or longer. Personally, he was inclined to believe that in many cases the sac was not ligated sufficiently high and the muscle slipped back to its original position. To illustrate this, the following case was of interest:

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A member of his household was operated on for inguinal hernia by a surgeon of high repute. Six months later there was a recurrence, and at the second operation, which was done by Dr. Moschcowitz, it was found that, with the exception of an occasional fine cicatricial adhesion, the transplanted muscles were not attached to Poupart's ligament.

The crux of the entire matter, the speaker said, was first to select the proper operation, then isolate and ligate the sac sufficiently high up and use adequate suture material. The transplantation of the cord should be done only in direct hernia.

DR. JOHN B. WALKER said he saw many cases of recurrent hernia at Bellevue and at the Hospital for the Ruptured and Crippled, and almost invariably, at the second operation, he found that the transversalis muscle had broken loose from Poupart's ligament. The reason for this, he thought, was that the sutures uniting the transversalis and internal oblique to Poupart's ligament were not placed deep enough, that is, they did not include a sufficient mass of muscle and unite it to the lower shelving edge of Poupart's ligament; further, the neck of the sac was not dissected free and ligated high enough. When Dr. Lorthior of Brussels was here at the meeting of the International Surgical Congress in April, 1914, he operated at the Ruptured and Crippled, using the method which he has employed most successfully in over 5000 cases of children, to dissect out the sac to an extremely high level; it was then cut off but *not* ligated, whereupon it retracted to a high level much above the internal ring. In cases of children, only two catgut sutures were used to unite the edges of the transversalis and internal oblique to Poupart's ligament. Most excellent results followed this very simple technic.

DR. GEORGE WOOLSEY said that in the hypogastric branch of the iliohypogastric nerve we had mainly a sensory nerve, the muscular branches being given off higher up, the fibres of this nerve, when it appeared in the course of the usual incision for an oblique inguinal hernia, were sensory or trophic. While it was wise, as several of the speakers had said, to avoid pinching these fibres in the sutures, their importance in preserving the muscular tone of the conjoined tendon was questionable.

As to the cause of a recurrent hernia, the speaker said he could not quite agree with the statement made by Dr. Moschcowitz. In a case where he did the second operation a few days ago the internal oblique muscle was well united to Poupart's ligament, and yet there was a recurrence in the form of a direct hernia. Such had been his usual



experience, and it was for that reason that not many years after the Bassini method was first introduced he abandoned the typical Bassini because he could not satisfactorily close the structures around the external ring to guard against this type of recurrence. He adopted a modification of the Halsted method by suturing the upper edge of the aponeurosis, with the conjoined tendon, to the deep surface of Poupart's ligament and overlapping the lower flap of aponeurosis on the upper flap. The cord is transplanted and lies superficial to the aponeurosis. This method was described independently by Andrews, and gave him much better satisfaction.

DR. LYLE said that after hernial operations the theory of keeping the patient's legs flexed was a very old one, dating back to the middle ages. The Albanians were long famous for their treatment of hernia, one essential feature of their treatment being the flexion of the leg on the abdomen. They strapped their patients to a board and, after scarifying the external ring, flexed the thigh on the abdomen and kept the limb in this position until healing took place.

DR. WILLIAM A. DOWNES said the paper of Dr. Dowd emphasized the importance of preserving the integrity of the iliohypogastric nerve as a possible factor in the prevention of recurrence of hernia, and that it should help teach us to be a little more careful in doing the operation.

As to neuritis or pain following operation for hernia due to pinching of the nerve in one of the sutures, the speaker said he could not recall a single instance of that kind unless the pain was due to a hæmatoma or some infection. Neuralgia or neuritis due to inclusion of the iliohypogastric or ilioinguinal nerve in the suture must be of very infrequent occurrence.

As to recurrent hernia after the Bassini operation, Dr. Downes thought they were practically all of the direct type. An arrangement of the sac that was not infrequently overlooked at the time of operating was the presence of a so-called double or saddle-bag variety of sac, and the condition was not in reality a recurrence, but an unrelieved hernia. As a matter of fact, recurrent hernia was much less common than one would expect, and the average operation for hernia gave quite satisfactory results. In his own experience for a period of ten years, from 1902 to 1912, inclusive, he operated on 582 cases of adult hernia at the General Memorial Hospital in the service of Dr. William B. Coley; 25 per cent. of which were bilateral. Of this total number of 582 cases, there were only 21 that had been operated on for hernia at some previous time and where a recurrence had taken place, which was really a small



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percentage when the fact was taken into consideration that the patients came from many sources.

As to the failure of the internal oblique and transversalis and Poupart's ligament to remain united, the speaker thought this was largely due to the fact that there was a deficiency or absence of sufficient muscle tissue, and that it was very often necessary to use the rectus muscle to help out.

DR. WILLIAM C. LUSK said that in operating upon recurrent inguinal hernia, he had observed the same relationship between the arched fibres of the internal oblique and transversalis muscles and Poupart's ligament mentioned by Dr. Moschcowitz, namely, that there was nowhere contact between these structures, the arched fibres being found back in their normal position. He regarded the restored normal relationship of these structures following an operation for inguinal hernia as probably due to the sutures not having held long enough for adequate union to have taken place.

He said that Dr. Halsted had early called attention to the importance of freeing the neck of the sac high so that the tied-off stump would retract well behind the abdominal wall out of the way of the suture line, which repaired the hernial defect. In a direct hernia Dr. Halsted turned back a flap from the anterior sheath of the rectus, which he sewed to Poupart's ligament to repair the inner portion of the floor of the inguinal canal. He did not, however, transplant the rectus muscle. Dr. Lusk said that in direct hernia he followed Dr. Halsted's method, a technic of doing which as well as of transplanting the rectus muscle he had once demonstrated before the Society (*ANNALS OF SURGERY*, lviii, 1913, p. 675). In those inguinal herniæ where the arched fibres and conjoined tendon could not be brought down to Poupart's ligament without tension, Dr. Halsted made a vertical incision through the anterior rectus sheath, cutting downward to the pubic bone, to afford relaxation to the former structures. Dr. Lusk said he had tried this manoeuvre and found it serviceable. Little was ever said specifically about the repair of the transversalis fascia which formed a large part of the floor of the inguinal canal and was, therefore, an essential barrier in maintaining the integrity of the abdominal wall in this region. One step which he was in the habit of practising in the operation for oblique inguinal hernia was, after the sac had been dissected free from the transversalis fascia at the internal ring and had been tied off, to close the opening in the transversalis fascia at the internal ring before suturing the muscles to Poupart's ligament. This procedure made a normal

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repair at the only situation where the integrity of the floor of the inguinal canal had been broken through and at the only situation as well where recurrence would be most likely to take place in this form of hernia.

DR. DOWD, in closing, said that before writing this paper he had consulted Prof. George S. Huntington, the head of the Anatomical Department of Columbia University, who stated that the fibres of the iliohypogastric nerve are so given off that the nerve should be preserved in this operation. Dr. John C. Vaughan, Instructor in Anatomy, also made a number of dissections and saw the fibres of the nerve running into the muscle. If the nerve is cut above the place where these fibres branch from the main trunk, the vitality of the parts which they supply must in a measure be diminished; also that of the corresponding portion of the external oblique aponeurosis. In the course of operation for recurrent hernia, he had seen firm union between the internal oblique and transversalis muscles and Poupart's ligament which had held for years. This union, however, was in the outer part of the suture line and not in the inner part. If the inner part had held, no secondary operation would have been needed. It is for the strengthening of this inner part of the suture line that nerve preservation is desirable. He believed proper suture much more important than nerve preservation, but the nerve should not be needlessly divided. He had not mentioned high ligation of the sac, or asepsis, because he considered these a part of the modern operation for hernia.

## BRONCHIECTASIS FROM FOREIGN BODY

DR. FRANK S. MATHEWS showed the right lung, removed at autopsy from a girl of ten years, who in February, 1914, had been operated on for enlarged tonsils and adenoids. The child's illness dated from this operation. There was persistent cough, with free expectoration of pus, without odor. She spent several months in a hospital for the treatment of tuberculosis, where on repeated occasions a needle had been inserted into the right pleura, but pus was never evacuated.

When the girl was admitted to St. Mary's Hospital for Children, several weeks ago, she was the picture of chronic sepsis. There was a wide range of temperature, with almost continuous cough and expectoration. There was dullness to flatness over the entire right chest, but nowhere were the breathing sounds absent, and they were generally of a bronchial character. The X-ray plate showed an appearance sug-

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gestive of consolidation rather than of fluid in the chest. There was a suspicion of a cavity near the apex. The von Pirquet test was negative.

After several trials, the needle withdrew a small quantity of pus. A section of rib was then removed in the mid-axillary line, and the subjacent lung, which was slightly adherent, was inspected. The finger was pushed through a small amount of lung tissue and entered a cavity about finger-sized extending directly inward. Into this a tube was inserted and for a number of days the drainage was profuse. The child's general health improved so that the temperature fell and she was able to be about the ward. During an attempt to dilate the sinus wall there was a sudden violent hemorrhage coincident with a fit of coughing, and the child died.

The specimen showed an unusual condition of bronchiectasis affecting all the larger and moderate-sized bronchi of the right lung. The bronchi were everywhere dilated and contained pus or were lined with pyogenic membrane. In places, small bronchi communicated with cavities one or two centimetres in diameter just under the pleura. The latter was adherent about the drainage opening, but elsewhere was surprisingly free from firm adhesions.

Dr. Mathews considered this a case of bronchiectasis resulting from the aspiration of a foreign body into the bronchi—in this instance probably a fragment of tonsillar or adenoid tissue. He could recall two or three instances of lung abscess resulting from this cause that had come under his observation, and others had reported cases of bronchiectasis following the inhalation of foreign bodies into the lung.

Dr. DAWBARN mentioned a case as reported recently by Dr. Reed, of Washingtonville, N. Y., at a meeting of the West End Medical Society of New York, of abscess of the lung following a dental operation. The patient had had several teeth extracted, while sitting upright in a dentist's chair under gas; and as one of them was not recovered, it was supposed that it had been swallowed. The patient began to suffer from pain in one side of the thorax, and from a cough, and finally showed all the evidence of an abscess of the lung. He was operated on by a surgeon in Newark, N. J., and the tooth was recovered from the discharge. The patient ultimately recovered. The rarity of the case deserved a record, and this instance of inhaled adenoid tissue reported here to-night was quite similar in principle.

Dr. KAMMERER mentioned a case, which he had shown to the Society some years ago, in which he had removed the lower lobe of the left

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lung. The patient was a woman of thirty, upon whom many operations had been done for the cure of bronchiectatic cavities in the lower lobe, without any result. During the last operation the entire lower lobe had been freed up to the hilum when a severe venous hemorrhage occurred, followed immediately by the aspiration of air, to which the patient succumbed in a few minutes. At the autopsy a primary pedunculated carcinoma of the left bronchus was found, which had almost completely occluded its lumen.

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